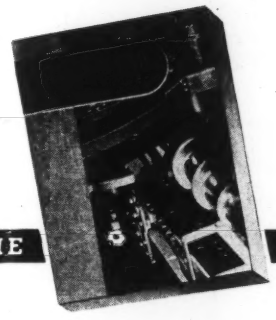

This Month's Cover: Cam feed and discharge end of package filling machine designed by Food Machinery and Chemical Corp.

MACHINE DESIGN

Vol. 22—No. 2 February, 1950

THE PROFESSIONAL JOURNAL OF CHIEF ENGINEERS AND DESIGNERS

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DESIGNING FOR PRODUCTION AND SALES • STYLING
MATERIALS SPECIFICATION • DESIGN ANALYSIS
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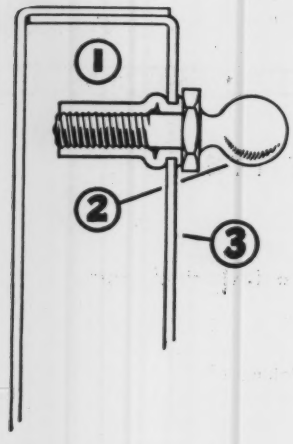
MD

3 tough fastening problems solved by one RIVNUT!

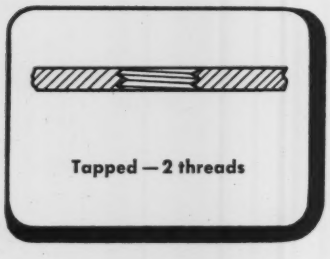


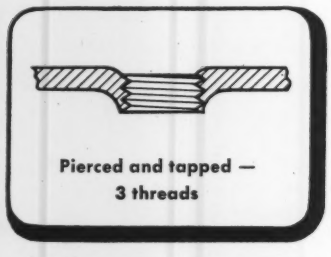
KITCHEN CABINET designers needed a rivet that 1) could be installed from one side only, 2) would serve as a nut plate for a knob attachment, and 3) could be installed *after* enameling. A B. F. Goodrich Rivnut proved the perfect answer.

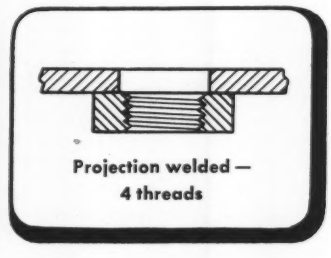
A flat-head Rivnut was inserted in the enameled sheet metal door, and upset with an easy-to-operate heading tool. The knob of the catch was then threaded into the clean, still-intact Rivnut threads.

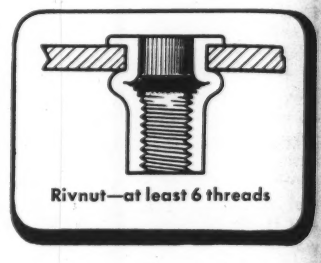
This simple solution saved many man-hours on this job. If you have a fastening problem, why not put it up to Rivnut engineers? Write to The B. F. Goodrich Company, Dept. MD-20, Akron, Ohio.

Compare these 4 methods of putting screw threads in thin sheet metal

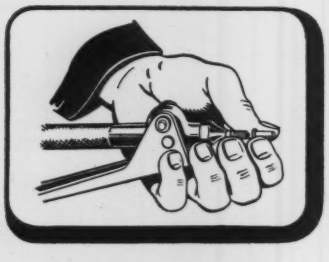

Tapped — 2 threads

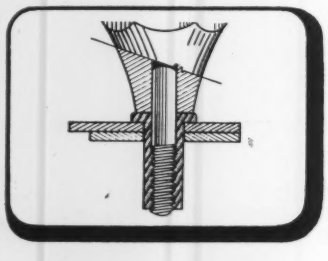

Pierced and tapped — 3 threads

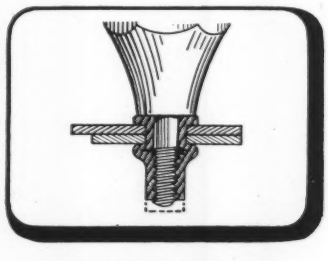

Projection welded — 4 threads

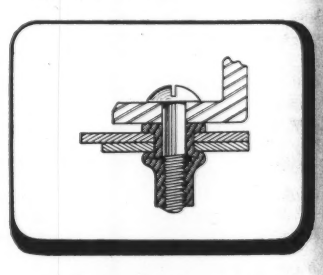

Rivnut—at least 6 threads

Rivnuts provide at least 6 clean threads in one simple operation!


1. Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.


2. Rivnut is inserted—head firmly against work, tool at right angles to work.


3. Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.


4. After upset, Rivnut threads are still clean and intact, ready for screw attachment.

B.F.Goodrich

RIVNUTS

The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

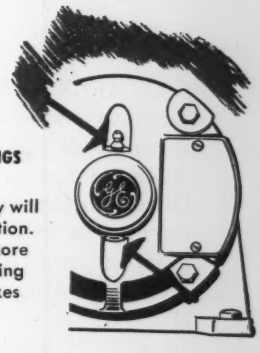
Demonstrates with motion how you can use Rivnuts to fasten TO *and* fasten WITH. Explains construction, gives proved applications . . . Write for your free copy today to The B. F. Goodrich Company, Department MD-20, Akron, Ohio.

...le-phase motor

...PACKED WITH *eye appeal*

These 4 wanted features in a complete line from 1 to 5 hp.

Meet the newest member of the famous Tri-Clad® motor family—G.E.'s new single-phase capacitor motor! Whether you sell it by itself or build it into your machines, you'll find it's got more operating "pluses", more sales-worthy features including freedom from radio or television interference. But see for yourself! Arrange with your nearest G-E office to inspect this new G-E motor now. For complete data, write for Bulletin GEA-5401. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

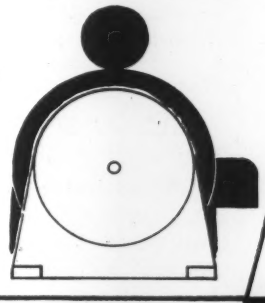


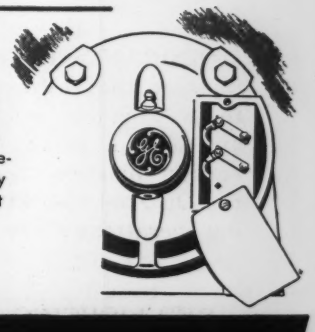
NEW! LONG-LIFE BEARINGS
easy to re-lubricate!

Bearings greased at the factory will run for years without re-lubrication. *But,* if they should need more grease, a pressure-relief greasing system with convenient fittings makes them easy to lubricate.

NEW! LIGHTER, MORE COMPACT
to save space, shipping costs!

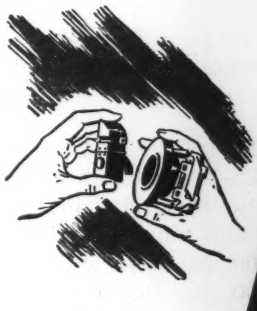
This new Type KCS motor has no capacitor on top, no conduit box on the side to increase over-all dimensions. It's not only more compact but 15 to 20 per cent lighter, too, depending on rating.





NEW! A TERMINAL BOARD
to make installation easy!

It's easy to hook up this motor. Remove a plate and there's an easily accessible terminal board built right into the endshield.



NEW! A TRANSFER MECHANISM
to make starting a snap!

Smooth reliable starting is assured by a simplified totally enclosed centrifugal mechanism and transfer switch. No rods or pins on the centrifugal mechanism to wear or get out of order!

REG U S PAT OFF

SINGLE-PHASE CAPACITOR MOTOR

TOPICS

NEW CERAMIC expands when cooled and contracts when heated. Known as Stupalith, the material is being tested by the Air Force, which believes it may have uses in jet engines. A lithium aluminosilicate processed to have excess silica molecules in solid solution with beta-spodumene, it can be formed and shaped by conventional methods of pressing, extrusion and casting.

ELECTROSTATIC GENERATORS, one developing 20,000 volts and another 6000 volts, are being tested by the Army for power supply to electron image tubes. Weighing 10 pounds, the generators are driven by spring motors and provide a more effective supply than present battery-converter sets.

COMPREHENSIVE INDEX of engineering services offered by engineering companies throughout the country is being compiled by the National Association of Engineering Companies. Questionnaires are being sent out state by state during the year. Those interested need not await a letter from NAEC but may send information on engineering services, expediting the compilation. Association address is 1601 Dime Bldg., Detroit 26, Mich.

ODORANTS for rubber and related products replaces the sulfurous, smoky-smelling odor of these products with the scent of "mountain air after a summer shower". Also useful for certain plastics, these odorants, developed by the Du Pont Co., withstand the heating and curing operations of the rubber.

RED LIGHTING for instruments will replace ultraviolet systems in Air Force and Navy planes following standardization of a lighting fixture. The new system will provide more uniform lighting and reduce both initial and maintenance costs.

COPPER SHOT for cleaning nonferrous metal parts imparts a lustrous, brilliant almost burnished finish of natural color to the work. The shot, developed by the American Wheelabrator and Equipment Corp., is made from pure copper ingot with a small amount of copper phosphorus deoxidizer to insure sound and dense shot.

SPOT WELDING procedures for producing better welds are reported by the Welding Research Council. For thin-gage sheet, fatigue strength is increased by applying ram pressures between 200,000 and 400,000 psi on the spot weld. For heavy gage structural steel up to ½-inch in thickness, it is desirable to temper the weld. This is accomplished by cooling the spot and subsequently reheating to the proper temperature by passing additional current while the weld is still between the electrodes.

SILVER CELL battery is now being manufactured successfully on a pilot basis. Developed by Yardney International Corp., the battery is less than one-third the weight of a conventional storage battery and less than one-half the volume. An alkaline storage battery utilizing silver and zinc as active materials, its ampere-hour efficiency approaches 100 per cent and the energy efficiency 85 per cent, being almost 20 per cent higher than that of lead and nickel batteries.

MAGNETIC RECORDERS, which showed promise for homes, offices, etc., are in the position of reappraisal by manufacturers, according to the N. Y. Journal of Commerce. Home acceptance has been retarded by the spread of television and through confusion caused by hosts of new recorders.

METAL SPRAYING technique using radioactive isotopes is being developed experimentally by Metallisation Ltd., of Dudley, England.Metal to be sprayed is fed into a gun in the form of two wires. Electric current between them causes an arc, melting the metal. Electrically conductive ionized air is used to blow the molten metal onto the surface being sprayed. The air is ionized by passing it over a radio-active isotope of phosphorus.

HIGH-STRENGTH magnesium alloys, the Mg-Zn-Zr system and the Mg-Al-Zn-Mn system, are under study for use in aircraft. Compressive and tensile yield strengths are in excess of 40,000 psi with ultimate strengths more than 50,000 psi. Reports also indicate successful development of a feasible method of atomizing magnesium alloys, and extrusions of powder without surface blistering.

FEBRUARY, 1950

The Key to Low Cost

IN THE hands of the design engineer lies the power to control costs to a degree sufficiently substantial to spell the difference between manufacturing profit and loss. What conscientious design for production can accomplish from a practical standpoint has been emphatically exemplified during the past few years in numerous widely diversified instances.

The erroneous idea that design for production applies effectively only where tremendous quantities are concerned must be eradicated. The principles of design to effect maximum economy can be utilized wherever several or more parts are to be made. In every case, however, design must be compatible with quantity—as quantity multiplies, processes having increasingly greater tool-up costs can be brought into play.

Total design effect upon manufacturing costs has been shown to average as much as 35 per cent of major overall costs—raw materials, equipment, direct and indirect labor, tooling, and engineering. In the low-quantity, heavy equipment field, actual figures show overall economies of 10 per cent and greater. Regardless of efficiency, tooling or purchasing efforts, the designer's influence sets the major limits beyond which no great improvement can be made.

Development of radically new methods of processing are normally practical only where high initial costs can be absorbed; and survey has shown that relatively few of all the types of machines manufactured ever exceed a production figure of ten thousand on a specific model.

Refinement of design by concentrating on basic operations available through the readily tooled and adapted production methods, therefore, is the foremost practical key to sharp reductions in costs—not revolutionary new production methods. Greatest advances in this direction can be achieved not by instituting a design "kibitzing" or review department with the difficulties attendant to split responsibilities but by developing alert, production-conscious design engineers.

H. L. Bolz

ASSOCIATE EDITOR

Production-conscious design can establish a decidedly favorable control over costs not only in large quantity but also in small-lot heavy parts manufacture

THE TARGET IS COST

By Walter G. Johnson
Assistant Chief Engineer
Grinding Machine Div.
Norton Company
Worcester, Mass.

WITH the return of the buyer's market, industry has been faced with the need for meeting competition and job requirements by bringing out new and better products. In common with other makers of machines, the Norton Company has felt this pressure for new designs to meet present-day demands, *Fig.* 1. With memories of past high costs in redesign, it has become imperative to analyze the problem carefully to determine a procedure which would permit new designs with full appreciation of today's costs.

The engineering department, therefore, faces the definite challenge of "cost" as a target without sacrifice of quality or features. Its design activity influences material and manufacturing cost to such an extent that by careful study of the manufacturing processes involved, it is possible actually to establish a control over these costs.

Plain Shapes Affect Cost Little

Design alone connot always or completely control costs. Given a drawing from the engineering department, the process man may find that equipment in his shop will permit him to produce the part in several different ways and on several different machines. Conditions and his experience usually dictate the method which will result in the lowest actual production cost.

An example of the foregoing would be a simple cube of steel to be made to a dimension of 1.870 plus or minus 0.001-inch, on each side, finished all over. In this case, the simple design has very little control over cost when considering the various ways in which this cube can be made. In one instance, the rough cube could be cut from a length of two-inch bar stock. Considering all possibilities, the cube could be cut from the bar with a hack saw, a machine saw, an abrasive cut-off wheel, or a hand gas cutting torch. Assuming that the shop has all these facilities, the hand hack saw would be ruled out as too slow a method. The cutting torch might also be ruled out because a ragged cut in a two-inch bar would require extra machining later for a smooth surface. A machine saw or an abrasive cut-off wheel would be the most logical choice for this operation.

Following cutoff, the rough cube must be reduced to the finished dimensions. There are several practical methods. The rough cube could be reduced to slightly oversize dimensions by means of a shaper, milling machine, planer, or surface grinder. The planer would not be a logical choice because of the small size of the part but the other three methods could be considered. Actually, to bring the cube to its required final dimensions and finish most easily, a surface grinder is best employed.

The following table illustrates the relative differences in costs in machining the rough-cut cube of metal to finish dimensions and tolerances by the

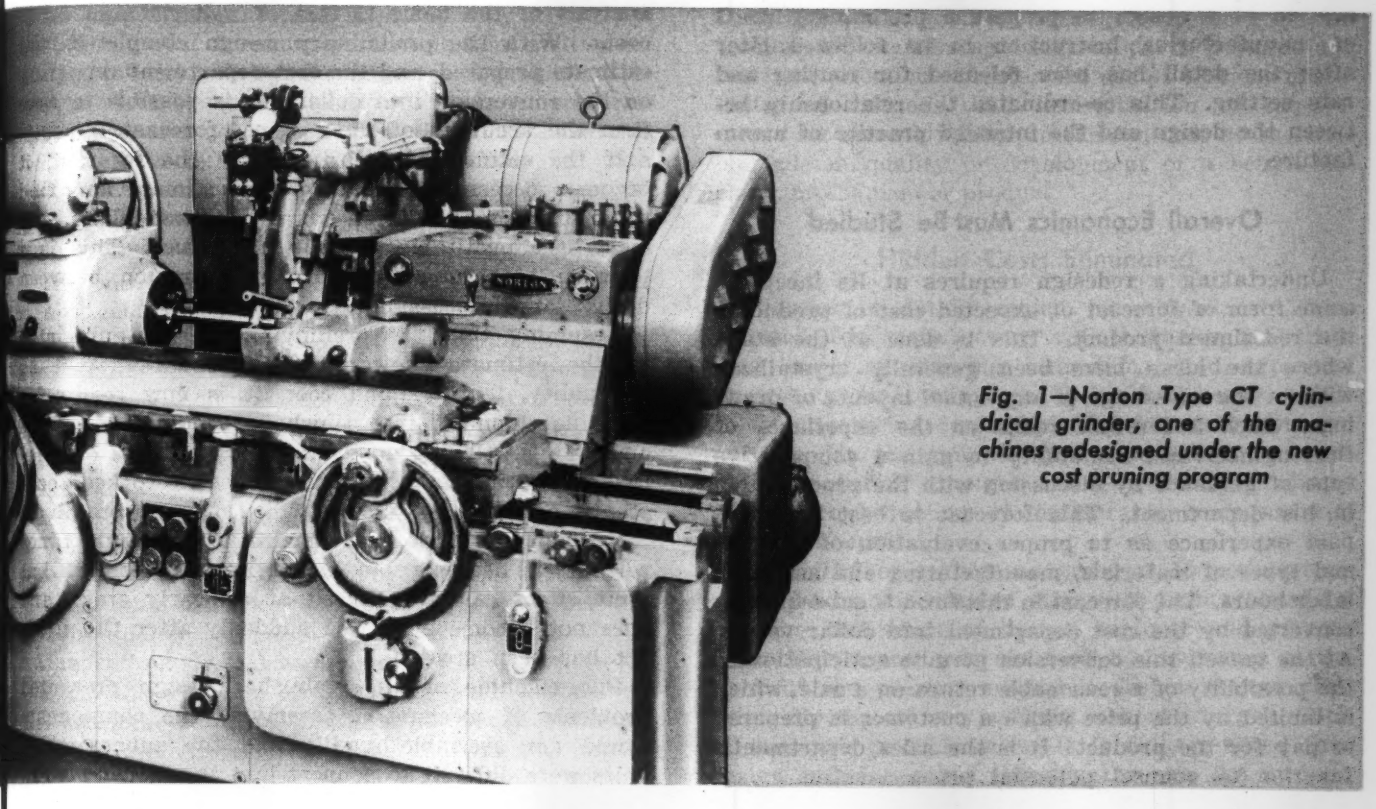


Fig. 1—Norton Type CT cylindrical grinder, one of the machines redesigned under the new cost pruning program

various methods considered practical. Percentage cost reduction is calculated using vertical shaper costs as a basis:

Machine Process	% Reduction in Cost
Vertical Shaper	0.0
Vertical Mill	12.5
Horizontal Shaper	28.2
Horizontal Mill	29.7
Horizontal-Spindle Surface Grinder	32.8
Vertical-Spindle Surface Grinder	32.8

Design Important With Complex Shapes

On the other hand, where more complex parts are involved, the design of a part *can* have a decided effect on the cost of manufacture. A more involved design than the simple cube, for instance, would be a combined piston and rack where the rack teeth are cut on the top surface of the piston cylinder. If full teeth are shown for the length of the rack section, milling becomes imperative, *Fig.* 2. However, if the designer permits partial teeth at the start and finish of the rack, it would make possible the use of a more productive type of machine, the rack cutting machine, *Fig.* 3. This example indicates the importance of some knowledge at the time of design as to abilities and limitations of various types of manufacturing equipment available, factors usually better known to a process man than to a designer. The design modified as in *Fig.* 3 represented a cost reduction of 59 per cent over that of *Fig.* 2.

It became necessary in a clutch design to produce specially chamfered lead edges on each clutch tooth. The first attempt at manufacture produced the desired shape satisfactorily but by a costly operation of end milling, *Fig.* 4. Further study by the process man evolved a more practical operation using a milling cutter, *Fig.* 5. The slight change in shape of the clutch tooth edge required to permit the use of the milling cutter was found satisfactory and readily approved by the engineering department. This relatively minor design change made it possible to show a cost reduction of 50 per cent in the manufacture of this part.

Realizing that close co-operation between the designer and the process man during the design period can serve to reduce or control cost, the Norton Co. has established a well-trained process man as a resident member of its engineering department for consultation. This process man is responsible to the production manager and not to the manager of research and engineering even though his working quarters are actually located in the engineering department.

The designers and detailers are thereby provided with a source of expert advice on manufacturing problems. From the very beginning of a design project, even before pencil is put to paper, the designer can discuss the proposed part with the process man. Such problems as the rack teeth on the combined

piston and rack can be discussed prior to any actual drawing, thereby saving time in redrawing the parts later. The process man is in a position at the inception of a design to prepare a preliminary draft of manufacturing instruction to be followed later after the detail has been released for routing and rate setting. This co-ordinates the relationship between the design and the intended practice of manufacture.

Overall Economics Must Be Studied

Undertaking a redesign requires at its inception some form of forecast of expected cost of producing the redesigned product. This is done at the stage where the ideas have been generally crystallized without the advantage of any actual layouts or drawings. Such a forecast relies on the experience of the engineer and his ability to gain a comparative type of guidance by discussion with the process man in his department. This forecast is best based on past experience as to proper evaluation of weights and types of materials, manufacturing and assembly labor hours. The forecast in this form is subsequently converted by the cost department into dollar values. At the outset, this conversion permits anticipation of the possibility of a reasonable return on a sale, which is limited by the price which a customer is prepared to pay for the product. It is the sales department's function to counsel potential price.

Assuming the forecast predicts an encouraging result, it is possible to support a request for authority to undertake a preliminary design sufficiently detailed in nature to permit a more careful second analysis of the basic factors of material and labor costs. With the preliminary design completed, the estimate prepared, and the cost department reporting on the conversion into dollars, it is possible to confirm the accuracy of the original forecast.

If the estimate fails to confirm the forecast, it becomes necessary to review the estimate and find ways to bring the design out of the loss column and make it a profitable product to produce. This is a problem best solved by joint co-operation between design and processing.

Assuming that the preliminary design supported by the estimate shows promise of satisfaction as to quality, features and cost, it is now ready for final development into finished layouts, assemblies and details. Having gone through the stages of forecast and estimating, it becomes possible to keep constantly alert for any factors which may tend to divert the design into more costly channels. There are times when it is necessary to accept these diversions but their effect can be realized at an early stage and does not become evaluated suddenly after the product has been created.

One machine of an established design presented problems of mechanism assembly; the components would not assemble readily and the subassembled units were difficult to connect into the machine. Engineering foresight established possibilities of elimi-

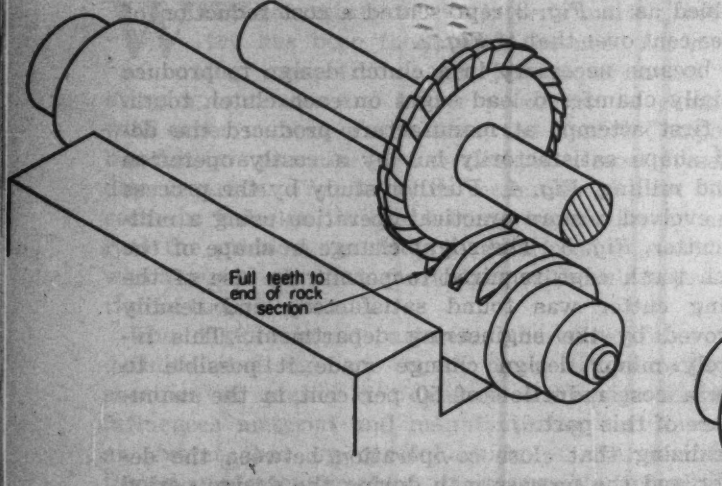


Fig. 2—Above—Combination piston and rack designed with full teeth at the end of the rack section requires a milling operation

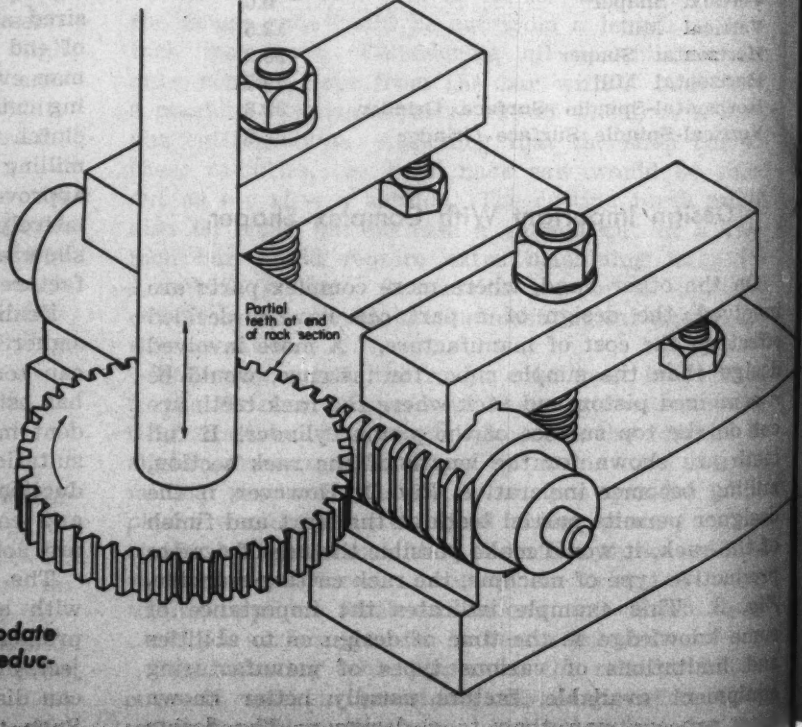


Fig. 3—Right—Design of rack teeth to accommodate cutter runout of gear shaper permitted a cost reduction of 59 per cent over milling

nating these problems by redesign. A forecast of cost of a proposed redesign indicated that the cost reduction might be substantial enough to warrant a development expenditure. A preliminary layout supported the cost forecast, permitting continuation of design activity. The end result was a completed redesign effort bringing a loser into a winner performance. As the job progressed there were several tendencies to refine the design excessively but with additional costs. Continuous tracking of the original target of cost reduction alerted engineering decisions and kept these influences under control.

The most disturbing experience to the engineer is the constant demand for changes after a model machine has been created, either because of better adaptability to available manufacturing equipment or to facilitate tooling. The availability of a process man to guide the design through its stages from a forecast to completed product is insurance toward reducing the frequency of such changes. Naturally, there is also a psychological advantage. If shop men see that the best processing method has been decided upon, they respect the design and are encouraged to contribute their best workmanship to produce the best in quality.

Unquestionably, those experienced in small-lot quantity, heavy parts manufacture—such as machine tool builders—can find an untold number of examples in their own experiences which confirm the importance of close co-operation of design with processing. These men will appreciate the effectiveness of having a well-trained process man as a resident in the engineering department, available for consultation at all times. Such teamwork pays dividends. It establishes a working arrangement for cost control in such matters as design of parts, patterns and castings, selection of materials, use of efficient manufacturing methods, and determination of requirements for assembly labor to the end that no sacrifice is made in quality or development of a better machine, mechanism or product.

Hidden Costs Eliminated

Changes in details which have previously been released for manufacture reflect themselves in a long train of drawing alterations, and expensive processing or tooling changes which only result in manufacturing confusion. Careful evaluation and guidance at the time of design results in a minimum number of changes which in turn contributes greatly to reduction of measurable costs as well as hidden costs.

Possibility of savings as great as 10 per cent on an entire machine design study has been realized by utilizing this team of design engineer and process man. This figure was obtained by reviewing in the light of the present method a design project done originally the old way without cost as a target. Such savings are possible when it is fully realized that design influences cost directly through the medium of the processing methods employed.

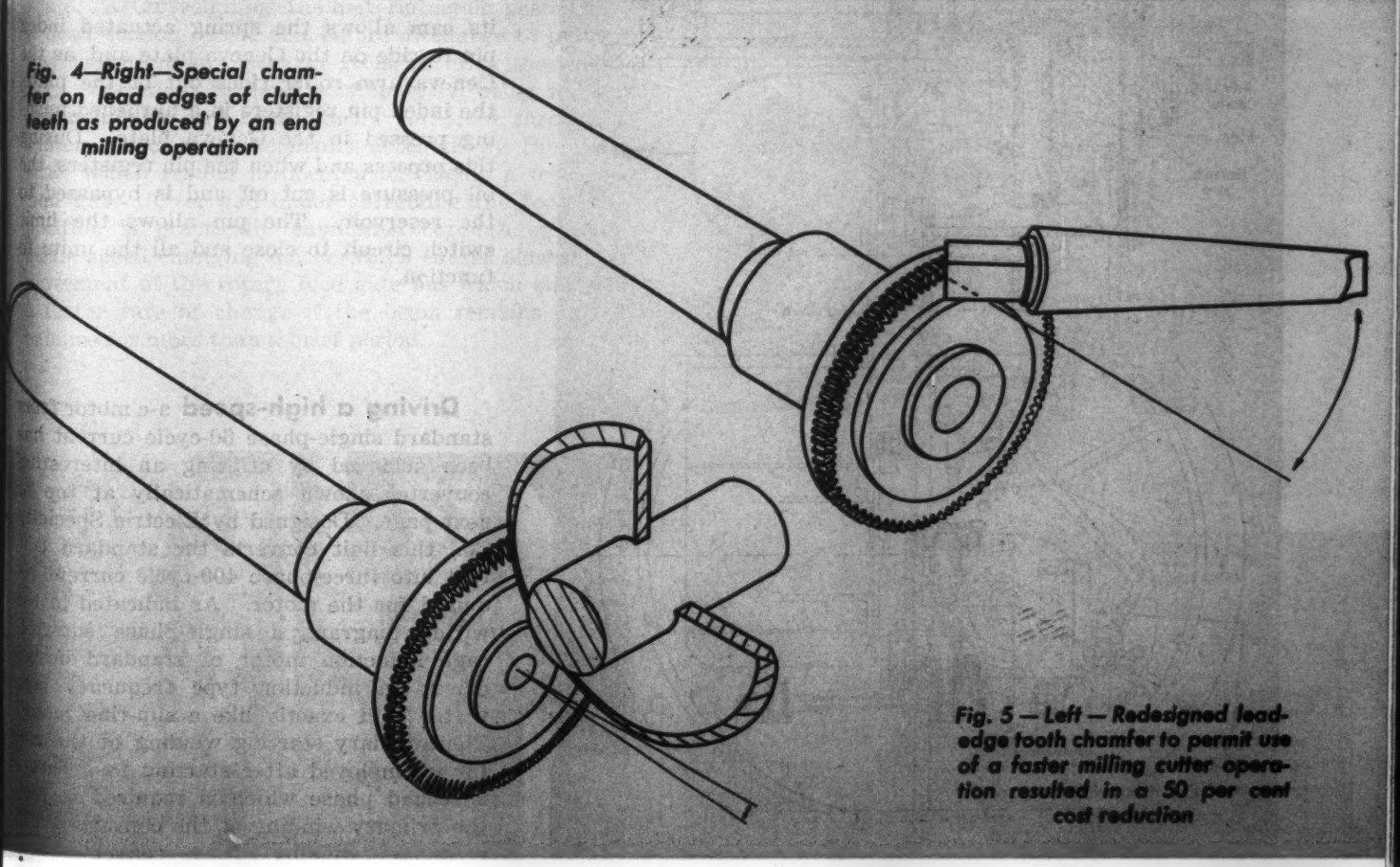


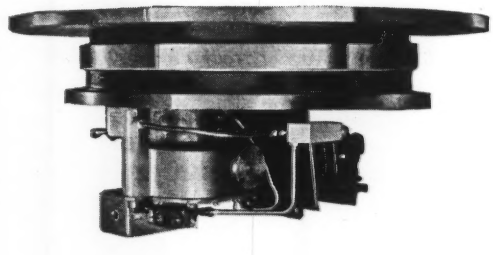
Fig. 4—Right—Special chamfer on lead edges of clutch teeth as produced by an end milling operation

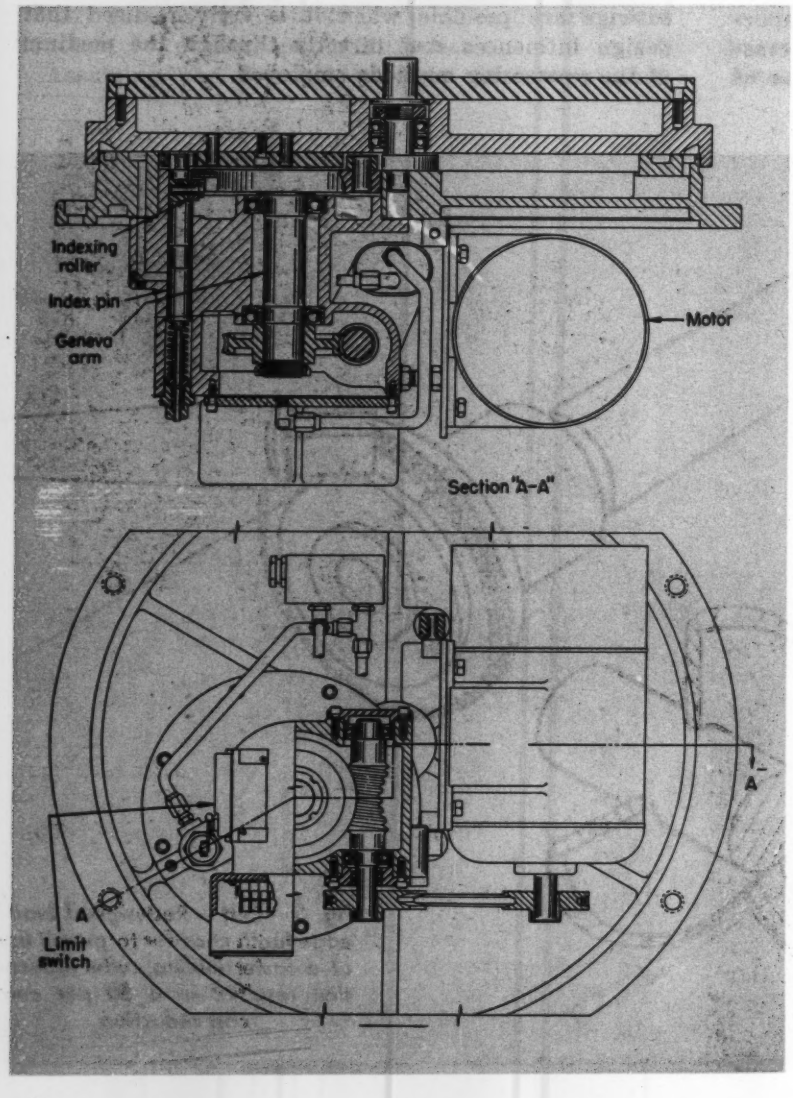
Fig. 5 — Left — Redesigned lead-edge tooth chamfer to permit use of a faster milling cutter operation resulted in a 50 per cent cost reduction

SCANNING the Field For Ideas

Automatic indexing table shown at right is a self-contained unit capable of indexing within plus or minus 0.001-inch. Referring to the drawing below, power to the Geneva arm is transmitted through V-belt and worm gearing. Underside of the Geneva arm has cammed surfaces. When the indexing roller, which is part of the index pin, pulls the pin from registering position, oil from a hydraulic pump bypasses around the pin and creates a pressure in grooving under the table. This raises the table, eliminating metal-to-metal contact while indexing to permit higher table loading with less horsepower input. Also when the indexing pin is in this position it actuates a limit switch, preventing drilling or other operations during this portion of the indexing cycle.

When the Geneva arm is nearing completion of its rotation, its cam allows the spring actuated index pin to ride on the Geneva plate and, as the Geneva arm roller rides out of the plate, the index pin registers in a hardened bushing pressed in the Geneva plate. During this process and when the pin registers, the oil pressure is cut off and is bypassed to the reservoir. The pin allows the limit switch circuit to close and all the units to function.

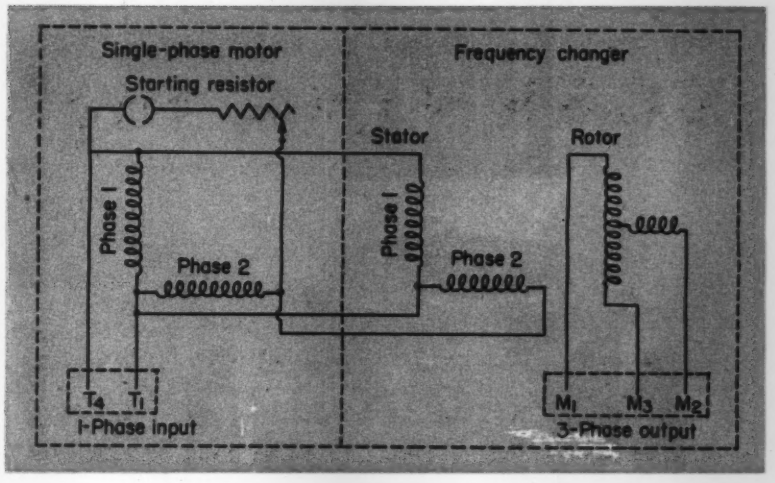




Driving a high-speed a-c motor from standard single-phase 60-cycle current has been achieved by utilizing an interesting converter shown schematically at top of next page. Designed by Electric Specialty Co., this unit converts the standard current into three-phase 400-cycle current required for the motor. As indicated in the wiring diagram, a single-phase squirrel-cage induction motor of standard design drives an induction type frequency converter built exactly like a slip-ring motor. The auxiliary starting winding of the motor is employed after starting to generate a second phase which is required to feed the primary winding of the converter. The secondary winding of the converter is a

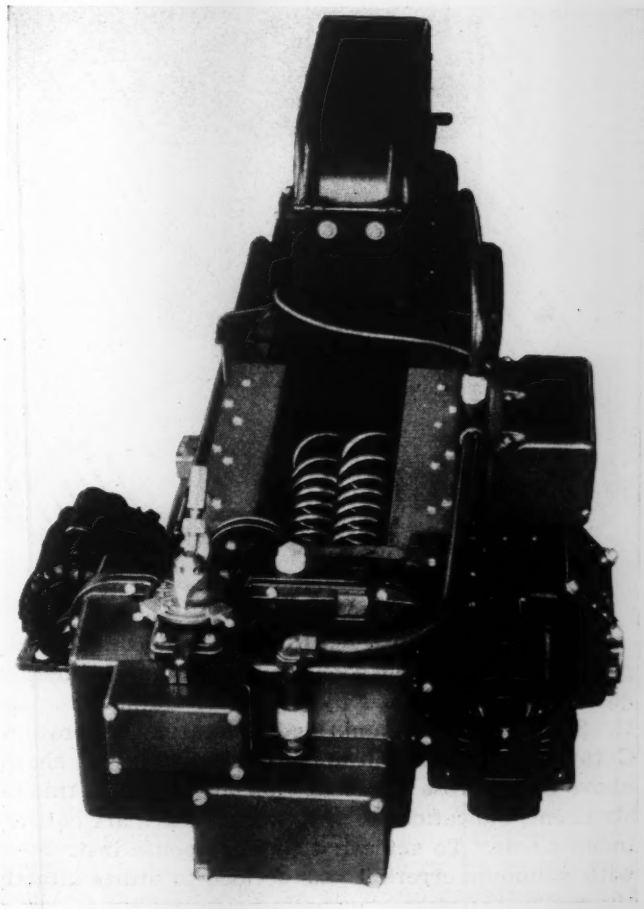
Scott-connected two-phase winding, resulting in a balanced three-phase output. In the design used it would have been impractical to accommodate the slots required for a three-phase winding of standard design.

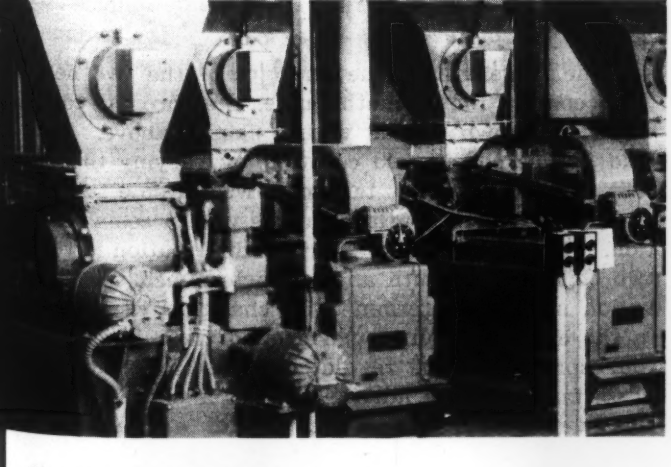
In this way standard current is transformed in the driving motor into mechanical power and into a two-phase system of 60-cycle frequency. This newly created system is converted into 400-cycle current in the secondary of the frequency converter. Finally, the high-frequency two-phase system is transformed into a three-phase system by means of the Scott connection This set proved to be economical and suitable for its purpose.

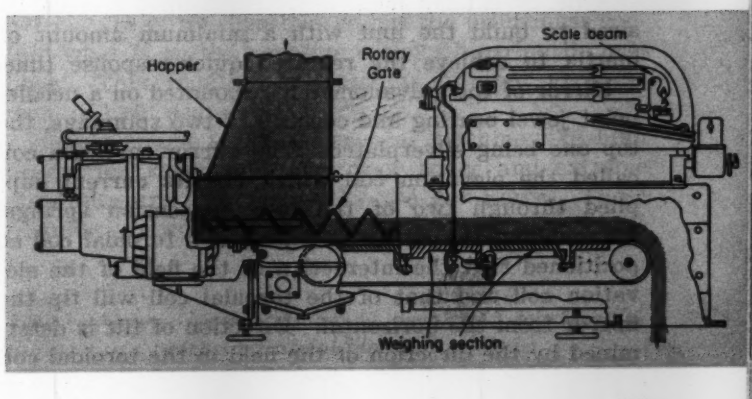


Continuous weighing of bulk material being fed into processing equipment through the battery of feeders, below, controls delivery within one per cent of any rate called for on the setting of the scale beams. Principle of operation of the feeder designed by Wallace and Tiernan is illustrated below at right. A view of the feeder with hopper removed, right, shows the rotary gate for controlling precise flow.

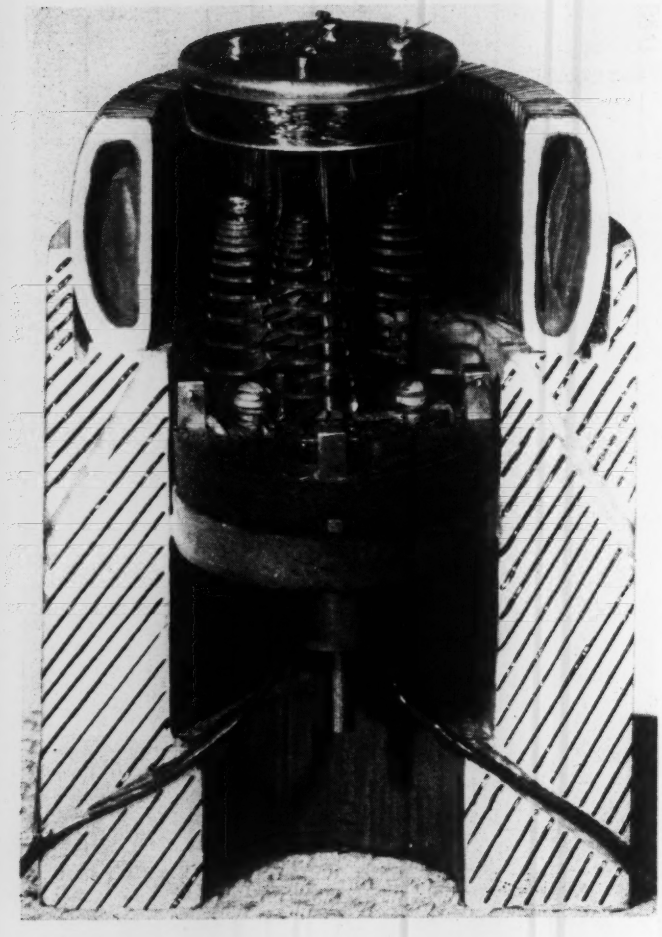
Material entering through the feed section falls onto a dead section of the weighing belt and is then carried over the weighing section. As the material passes over this section, the weight of the material is counterbalanced by a preset weight on the beam scale. After weighing, the material again passes onto a dead section of the belt before discharge to prevent any variations in discharge from affecting the weighing. Variations in density of material being fed are automatically and continuously corrected through a system of electrical controls actuated by the beam scale which results in opening or closing a feed section gate. Over and under correcting the feed gate position is practically eliminated through an automatic speed changing device which causes slow initial movement of the rotary feed gate but which shifts to a faster rate of change if the beam remains out of balance for more than a brief period.

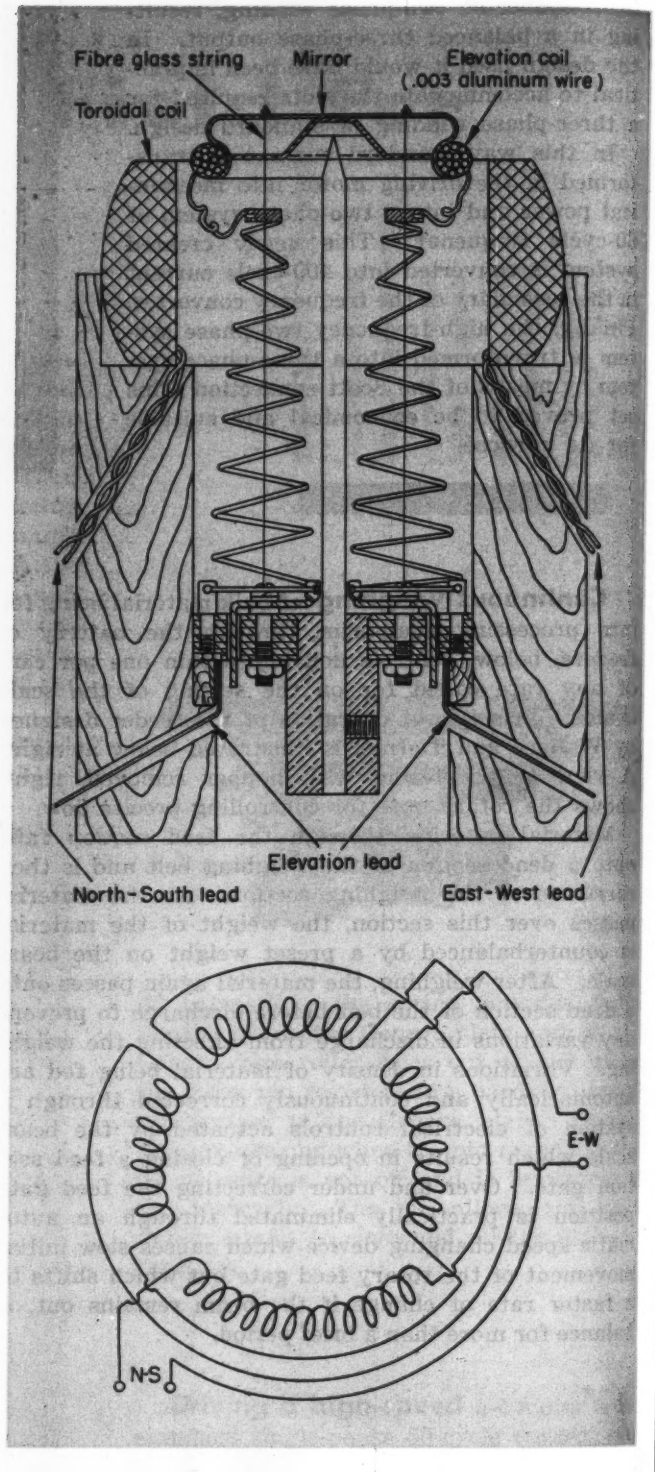






Ideas





Two-dimensional scanning or plotting of two parameters is possible with the aid of a novel spherical galvanometer designed by Alfred S. Gutman for the U. S. Air Force Cambridge Research Laboratory. Cutaway view without its spherical dome is shown above and a cross sectional view at right. In this instrument, indications of the two variables are entirely independent. To achieve a rapid-response instrument with minimum errors it was decided to utilize directly the actions of electromagnetic fields instead of gears, selsyns or similar means. Furthermore, it was desired to build the unit with a minimum amount of inertia to achieve the required quick-response time.

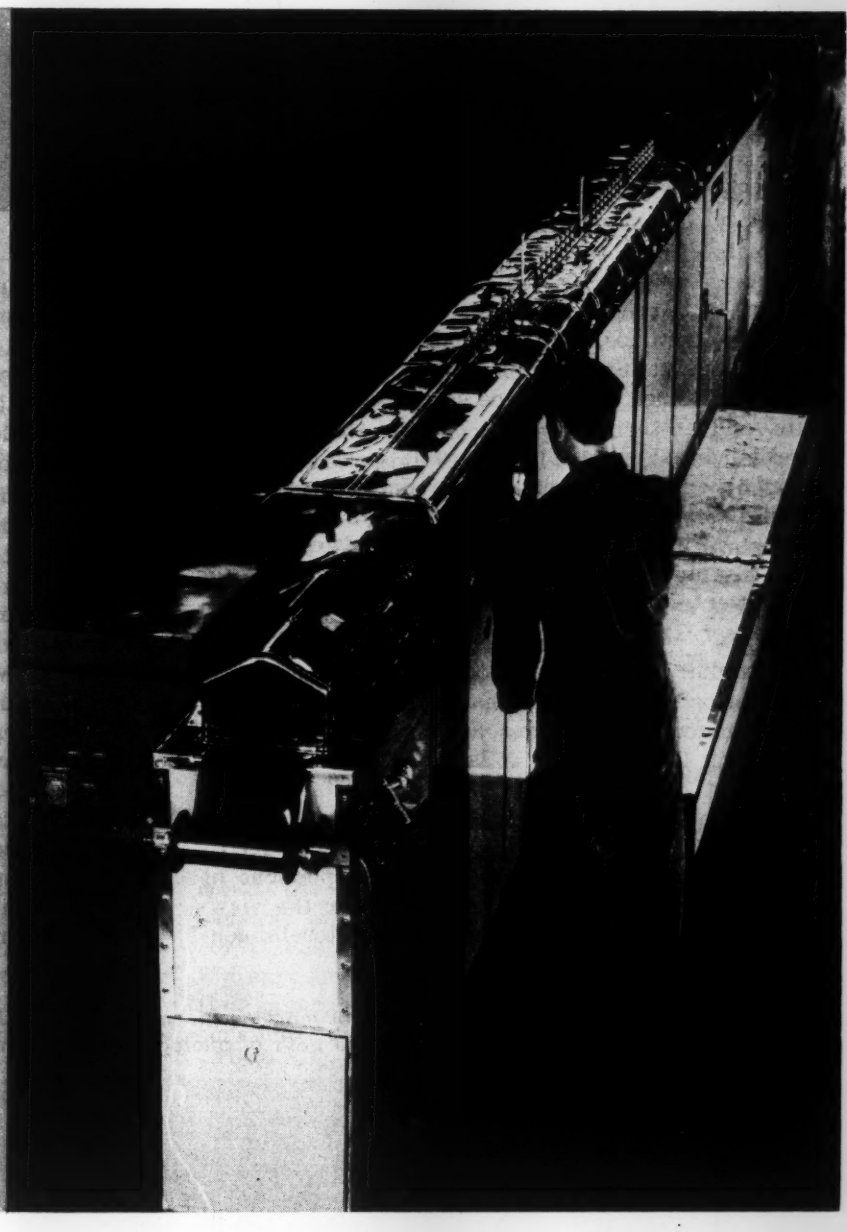
Mirror of the galvanometer is mounted on a needle-point jewel bearing and consists of two spinnings, the top one being silverplated. The mirror carries a coil called the elevation coil which has its current supplied through two of the four suspension springs. Surrounding the mirror assembly is a toroidal coil so positioned that the interaction of the field of the elevation coil and that of the toroidal coil will tip the mirror from the horizontal. Direction of tilt is determined by the direction of the field in the toroidal coil and the tilt angle by the strength of the two fields.

To control the azimuth angle, the toroidal coil is wired as shown in the wiring sketch above. Total field in this coil is held constant by varying the current at the East-West terminals with a sine function and at the North-South terminals with a cosine function. By variation of the current distribution in these two coils, the azimuth angle is determined. The elevation angle is determined by changing the current in the elevation coil wound around the mirror. The four springs can be regulated for even tension and are attached to the mirror by glass fibers. Light reflected from the mirror can scan a hemisphere.

Memory Control

. . . speeds processing of aerial photographs

By J. S. Goldhammer
Photographic Laboratory
Engineering Division
Air Materiel Command
Dayton, Ohio



PROCESSING aerial film or prints at the rate of 10,000 to 20,000 feet per day is achieved by the semiautomatic machine illustrated in *Fig.* 1. Sectionalized and lightweight construction is employed so that the machine may be airborne and easily set up in the field without using hoists. Developing of film is automatic and, with the exception of the operator setting controls for the printing exposure, the printer is also automatic. A photoelectric unit indicates film density and a "memory" control assures proper exposure when the film is in printing position.

Named the Air Force type A-7 processing machine and D-1 printer, this machine was developed by Technical Service Inc., Plymouth, Michigan in co-operation with the Photographic Laboratory, AMC at Wright Field to meet the work-load expected in future military operations.

It might seem that commercial equipment could be adapted to Air Force requirements. Unfortunately, units that are entirely satisfactory for commercial use are unsuitable for aerial photographic work. In aerial reconnaissance photography, certain negative defects are of no consequence but the print must contain what is on the negative without blurring its outlines. This requires an entirely different arrangement of light source in the printer.

Requirements for a commercial machine like high production rates, minimum floor space and extreme durability are also desired by the Air Force. These features are compromised in the Air Force machine

Fig. 1—Above—Air Force's newly developed machine for processing aerial film and prints

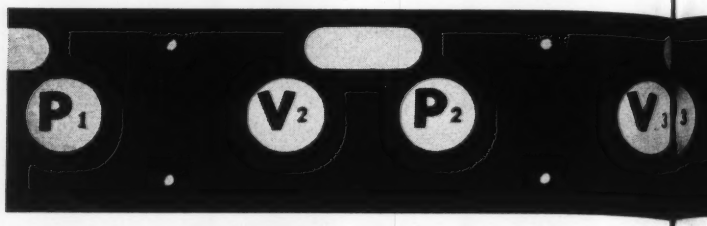
by additional requirements including:

1. Mobility through sectionalized construction
2. Light weight for air transport
3. Minimum power consumption for field use
4. Daylight operation because of difficulty in making tents and portable building light-tight
5. Shock resistance to withstand handling and shipping.

To realize these features, while at the same time not increase overall size or adversely affect production rate or service life, requires the application of techniques, methods, and materials not normally employed in the manufacture of photographic processing equipment. Since the machine satisfies these requirements, and at the same time, exceeds the output of any commercial unit of comparable size, power requirement and life expectancy, a detailed examination of its design features should prove of interest.

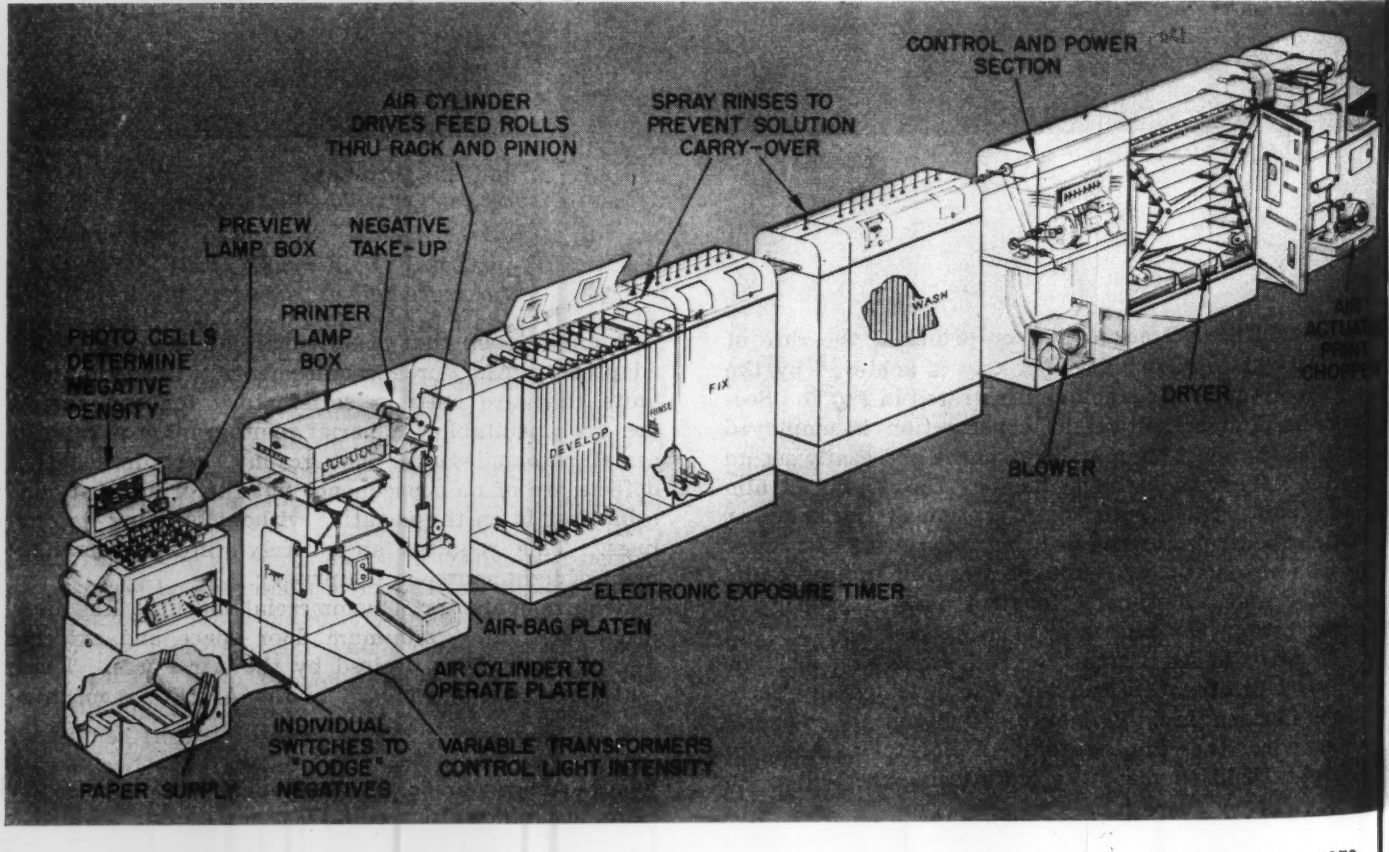
As shown in *Fig.* 2 the machine consists of the following six units: Previewer, printer, processing section, power and control section, dryer, and take-up and chopper.

PREVIEWER: In this section the negative is examined prior to printing so that proper exposure may be determined. It contains an illuminated viewing box, having 24 incandescent lamps, 15-watt size. It is an exact duplicate of the lighting system in the printer. The 24 lamps are individually controlled by toggle switches, so that the negative may be "dodged". That is, lamps may be turned off under portions of the negative having little exposure. Over the viewing glass is a hood containing eight photocells connected to a microammeter. After dodging his negative, the operator manipulates a variable transformer controlling the power input to the viewing lamps. By manipulation of the variable transformer, the operator gets a light setting, as recorded on the microammeter, of desired intensity. It is necessary to transfer this information to the printer section.



Four identical sets of toggle switches are mounted on four sides of a rotatable drum, of which one side is apparent through the front panel of the previewer. On the top of the previewer, in front of the viewing panel, a translucent panel as shown in *Fig.* 3 is mounted with individual lamps under each symbol. By seeing which panel is in action, V_1, V_2, V_3, or V_4, the operator knows which variable transformer control to use. At any time there is one negative on the previewer, one on the printer, and two in between. Therefore, by a system of brushes from the toggle switches and two sets of contacts, one to the previewer lamp box and one to the printer lamp box, a setting made on the previewer may be transferred to the printer. A simplified circuit diagram, shown in *Fig.* 4 indicates the wiring for one toggle switch

Fig. 2—Arrangement of machine for making prints, showing features of the sectionalized units and path of photographic film and paper through them



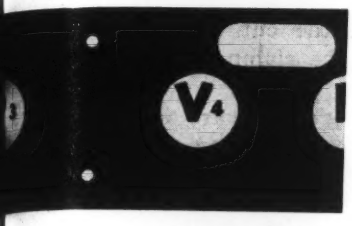


Fig. 3—Portion of previewer indicator lamp panel which indicates which of the four printing circuits is in operating position

and the variable transformer powering that set of switches. There are, of course, 4 sets of 24 such switches, with one variable transformer for each set. Thus, the previewer is actually a memory device storing the data until the negative to which it applies reaches the printing station.

At present, negative advance and drum rotation are manual; in future units, both will be powered and interlocked. On the present unit, a space is provided on the indicator panel to note negative numbers, so as to key negatives to the proper panel. In the base of the previewer is the paper supply chamber, having a limit switch-actuated warning buzzer which is set to make contact when 50 feet of paper (about 2 minute's supply) remains. A splicing unit, to splice the new roll to the tail of the previous one, is mounted on a pull-out slide together with the paper roll-carrier.

PRINTER: The lamp house of the printer is identical to the previewer lamp house. During the exposure contact between paper and negative is effected by a rubber air-bag platen, inflated to about 2½ psi. This platen is operated through a toggle linkage by a Bellows solenoid-valve-actuated air cylinder. Pulses for platen up and down cycles are initiated by timing cams striking roller-arm limit switches. Printing lamp exposure is initiated by a similar arrangement. Duration of exposure is controlled by a Photoswitch electronic timer.

Paper feed is then achieved by rubber feed rolls, operated by another Bellows air cylinder initiated by a timing cam and a precision limit switch. This air cylinder, driving the feed rolls through a rack and pinion arrangement, may be converted from 18½-inch feed (for 9 × 18 negatives) to 9½-inch feed (for 9 × 9 negatives) by inserting an additional block on the arm which controls the limit switch for the cylinder's solenoid valve. To convert from 9 × 18 to 9 ×9 operation, it is merely necessary to insert this stop block and replace the single-lobe cams with double-lobed cams, giving two impulses per shaft revolution. Both sets of cams are mounted on splined shafts and may be moved into or out of operating position as desired.

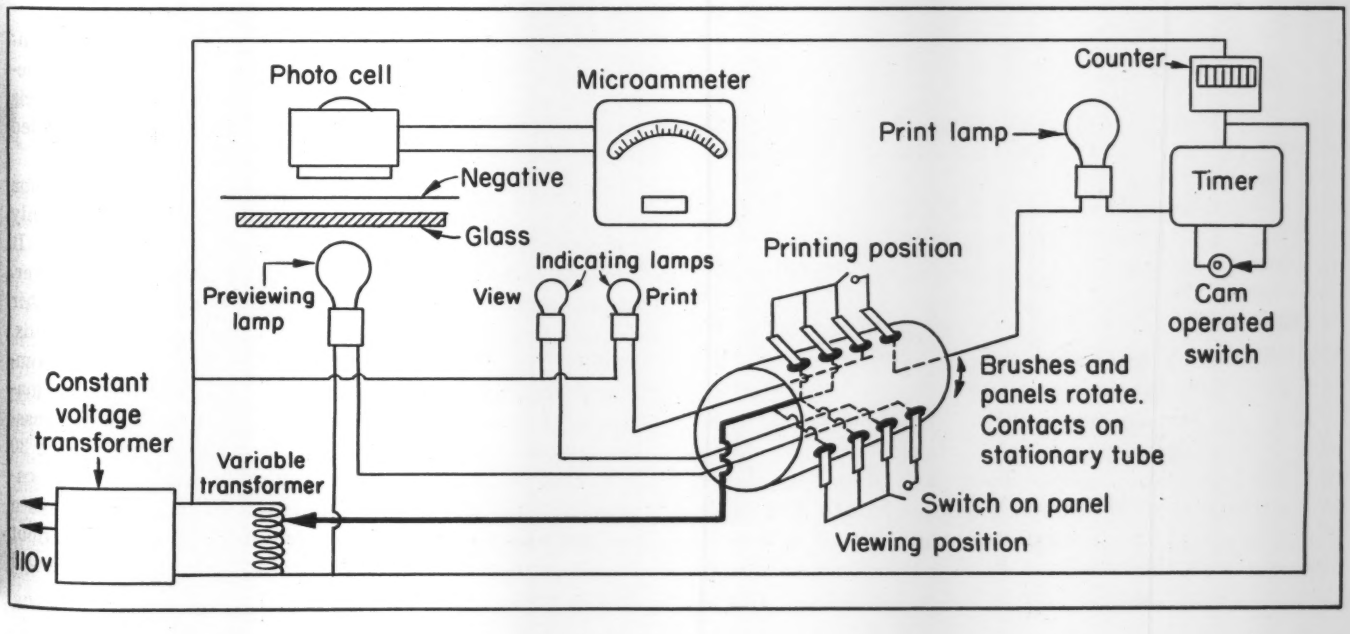
To expedite operation, toggle switches to control the printing-platen and feed-roll actuating cylinders are mounted on the printer. Among other features, a safelight switch, viewing-windows which may be closed off for panchromatic material, a Solar automatic constant-voltage transformer for the previewing and printing lamps, and an electric Veeder-Root exposure counter are installed.

Paper Feeds At Constant Rate

Because a 1000-foot roll of paper weighs over 30 pounds, starting the roll turning, feeding 18½ inches for one second, holding the paper one second during exposure, and then feeding again is undesirable. Instead, the principle of operation of motion-picture cameras is employed, that is, the supply roll moves continuously, 18½ inches is taken from a slack loop for exposure, while at the other side of the platen this intermittent motion is reconverted to the continuous motion required for the developing tanks by another slack loop. This arrangement is diagrammed in *Fig.* 2.

The units discussed thus far are required solely for paper prints. For processing negatives, a 1000-foot

Fig. 4—Simplified wiring diagram for previewer and printer units, showing memory device and one of the four circuits for one previewer and printing lamp



film magazine is installed in their place. This magazine is fitted with a follower-arm on the film roll, giving the unused film footage. When the footage falls to 50 feet a warning buzzer sounds until a splice to a full magazine is made. This can be done in absolute darkness in about 30 seconds. In the event dark operation is impossible, 50 feet of unsensitized leader is spliced to each end of the negative roll when the magazine is loaded, so that the splice may be made with the lights on, without fogging the negatives.

PROCESSING TANK: Except for their remarkably light weight, achieved by use of welded stainless steel, Type 312, the tanks are similar to commercial units with no exceptional features.

POWER UNIT: Located about midway in the length of the machines, the unit has, on its face, solenoid circuit breakers which may be tripped or reset manually. These breakers control the main drive, the previewer, printer, air compressor, supply and drain pumps, and the dryer blower and heaters.

In the power section is the main drive, a Graham variable-speed unit, which may be manually set for any speed from 0 to 35 fpm. Below the drive is the blower to supply air to the dryer. Provision is made to interpose a dehumidification unit, either chemical or refrigerative, or to vent the humid exhaust from the drying cabinet to the outside by flexible ducting.

DRYER: Behind the power unit is the drying cabinet. The paper takes a path best described as a folded spiral, taking successive loops toward the center, and then reversing direction in increasing loops. Thus, the greatest possible surface is exposed for the minimum cabinet dimensions. Infrared heater strips evaporate the moisture from the film or paper. Air is blown across the cabinet between successive passes of paper to absorb the liberated moisture. The humid air is then collected in the hollow doors of the cabinet. Exhaust air may be vented, dehumidified, or recirculated depending on ambient conditions. At this point, it should be noted that because of the high wavelength radiation employed, no differential drying rate between white and black areas is encountered as is the case with infrared lamps.

Dryer Efficiency Is Doubled

With a power input of 8000 watts, and a cabinet volume of 30 cubic feet as compared to 5400 watts and 15 cubic feet for the Air Force type A-10A dryer, previously the most efficient, drying rates of 30 fpm have been recorded, compared to 8 fpm for the A-10A under similar conditions. In other words, with 150 per cent of the power and 200 per cent of the volume of the A-10A, 375 per cent of A-10A output is achieved, more than doubling the efficiency of the best previous unit.

TAKE-UP AND CHOPPER UNIT: In the base of this unit is housed a ¾-hp air compressor which powers the printer platen, paper feed, and chopper blade. For cutting the continuous paper web into 9 x 9 or 9 x 18-inch prints, a hardened and ground wheel is driven across the web by a double-ended air cylinder. Before cutting, another air cylinder clamps the paper to prevent motion during the cut. A small hump forms in the web behind the clamp but springs out upon release of the clamp.

Both cutting and clamping actions are accomplished by Bellows air cylinders, actuated by a pulse from a Photoswitch timer. The timer, in turn, is triggered by two phototubes through separate amplifiers, each actuating a relay. The two relays are in series in the timer pulsing circuit, thus requiring a "white" indication from both edges of the web simultaneously. This will only occur between prints. The timer is needed in the circuit to prevent repeated cycling of the chopper when a continuous clear strip passes the phototubes. The timer design is such that only one pulse can be initiated per actuating cycle. Before another timed pulse can be initiated, the actuating circuit must be opened, i.e., a print pass the phototube scanners. In effect, the timer converts a signal of variable duration to a pulse of proper duration.

Treated Aluminum Utilized

CONSTRUCTION: In the sections exposed to corrosive photographic fluids, construction is stainless steel except for minor use of inert organics like Neoprene, fiber and phenolic sheet and bar. The tank base structures, however, are heavy-sectional aluminum sand castings, coated with zinc chromate primer and finished with baked Amercote chemical-resistant paint. Weight and machining problems made the use of stainless prohibitive for these bases. However, after eight months use, no traces of corrosion are apparent.

The stainless steel tanks are enclosed in an insulating jacket consisting of Fiberglas panels sealed in Pliofilm envelopes to prevent absorption of condensation moisture and spillage, with consequent loss of insulating properties. The insulation is retained by an outer jacket of ½-inch waterproof plywood, finished inside and out with Amercote.

All other units are constructed of square cross-section aluminum tube, welded to form a framework. Boots Cagenut fasteners are inserted in the framework to retain Amercoted 52S aluminum alloy panels and stainless corner moulding strips.

Although this construction is undoubtedly expensive compared to steel, cast iron, cypress or stoneware tank construction, weight-saving considerations are of the utmost importance in equipment intended for air transport.

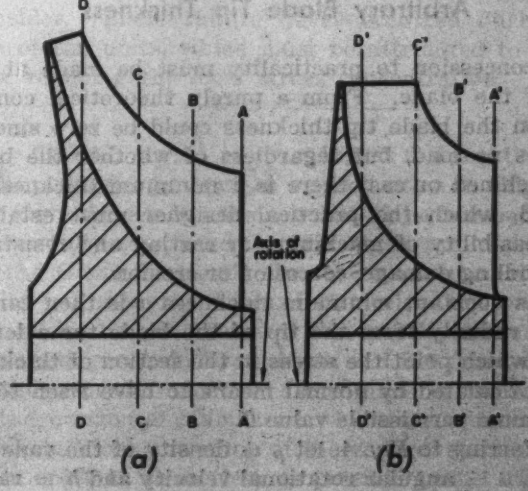
Extent of the weight saved by this construction can be appreciated by a comparison with the only commercially available machine of like capacity. It weighs 7100 pounds and does not include a printer. In comparison, the combmined weight of the Air Force's processing machine and printer is 3800 pounds. Packed for shipping the weight is 5100 pounds, compared to over 10,000 pounds for the commercial machine. Produced in comparable numbers, the processing machine and printer is expected to cost about 30 per cent more than a commercial unit of like capacity. Advantages to the Air Force of decreased weight and sectionalization for field handling without hoists or other equipment far outweigh the increased initial cost.

Impeller Blade Design

. . . for maximum strength with minimum weight

By Harold Woodhouse
Vice President and General Manager
Power Generators Limited
Trenton, N. J.

Fig. 1—This method of stress analysis is especially applicable to centrifugal compressor impellers (a) and radial-flow turbine wheels (b)



GAS turbines were generally unsuccessful until materials were developed which possessed the particular property of retaining a large proportion of their room-temperature strength at temperatures which made the gas turbine thermodynamic cycle possible—and the minimum temperature level of operation is, roughly, 1000 F.

It is not surprising, since increase of initial gas temperature is essential to increased turbine thermodynamic cycle efficiency, that operating temperatures have crept up behind every improvement in metallurgy, so that the blade-stress safety factor is always, figuratively, one jump ahead of the devil. Because of this constant tug-of-war between available strength and desired operating temperature, the designer must effect a compromise betwen the major characteristics which should be incorporated in the blading design.

There are three principal design features desirable

in a turbine and compressor blade design:

1. Close adherence to the best principles of aerodynamic contouring of the blade profiles
2. Minimum blade stresses coupled with minimum weight
3. Maximum resistance to blade vibration.

These qualities cannot be built into the blade profile entirely to the exclusion of each other; neither is it possible to ignore the modifying effect of the method of manufacture that must be used as a result of the selected design.

However, since the designer generally starts out with what he would like to have in the design and modifies it as required as he goes along, this article concerns itself only with the development of a mathematical expression for obtaining the *ideal radial profile* of a blade to give minimum weight for a selected maximum tensile strength, as listed under ideal requirement 2 given in the foregoing.

Furthermore, while the method described here might be applied to axial-flow compressor and turbine blades, it is most useful for and is generally applied to blade sections of radial and mixed-flow compressor impellers and radial-flow turbine wheels where the blades are integral with the hub section. It might be noted here, since it represents an important trend in axial-flow compressor design for both aircraft and land use, that a radial-flow centrifugal impeller is being used, after a number of axial stages, as the last compressor stage. This provides a radial-flow discharge without the losses of a stationary elbow.

The general method of stress analysis attack is to obtain several hub and vane sections by slicing the impeller or turbine wheel half cross-section into parallel radial planes at selected points as shown by *AA*, *BB*, *CC* and *DD* in *Fig.* 1*a* and *A'A'*, *B'B'*, *C'C'* and *D'D'* in *Fig.* 1*b*. If *Fig.* 2 is taken as representative of one of these vane sections—each of which is considered as being of one-inch depth at right angles to the plane of the paper for calculation purposes, regardless of the distance apart of *AA*, *BB* or *A'A'*, *B'B'*, etc.—the method outlined may be used to check an existing vane contour to see where surplus metal is being carried, or it may be used to build up from scratch an ideal (stresswise) vane contour.

Arbitrary Blade Tip Thickness

A concession to practicality must be made at the tip of the blade. From a purely theoretical consideration the blade tip thickness could be zero since it carries no load, but regardless of whether the blade is machined or cast there is a minimum thickness, *a*, *Fig.* 3, which the practical designer must establish for feasibility of machining or casting and resistance to handling damage, corrosion or erosion.

This constant minimum thickness *a* is then carried down radially from the tip of the blade for a length *b*, at which point the stress in the section of thickness *a* is calculated by normal means to have risen to the maximum permissible value *C*.

Referring to *Fig.* 4, let ρ = density of the vane material, ω = angular rotational velocity and h = radius from axis of rotation to bottom of the straight-sided vane portion. Considering a strip of vane 1 in. wide by dy in depth, centrifugal force = mass $\times$ $r\omega^2$ = $\rho a\ dy \times \omega^2\ (y+h)$. Integrating with respect to y between limits $y = 0$ and $y = b$,

$$\int_o^b \rho a\omega^2 (y + h)\,dy = \rho a\omega^2 \int_o^b (y\,dy + h\,dy)$$

$$= \rho a\omega^2 \left(\frac{b^2}{2} + hb \right)$$

= centrifugal force due to rectangular vane tip

$$= K$$

EVALUATION OF b: The stress at the root of the rectangular parallel section is by agreement equal to C and it is to remain at this value throughout the remainder of the vane. So, for a 1-in. strip of vane (area = $a \times 1 = a$),

$$\frac{K}{a} = C$$

$$aC = \rho a\omega^2 \left(\frac{b^2}{2} + hb \right)$$

$$\frac{b^2}{2} + hb = \frac{C}{\rho\omega^2}$$

Multiplying by 2 and equating to zero,

$$b^2 + 2hb - \frac{2C}{\rho\omega^2} = 0$$

$$b = \frac{-2h \pm \sqrt{4h^2 + \dfrac{8C}{\rho\omega^2}}}{2}$$

$$= -h + \sqrt{h^2 + \frac{2C}{\rho\omega^2}}$$

DETERMINING VARIABLE VANE SECTION: Let F = centrifugal force at variable point P, and m = mass of section of x width and dy length, *Fig.* 5, (note that origin of y varies from *Fig.* 4). Then

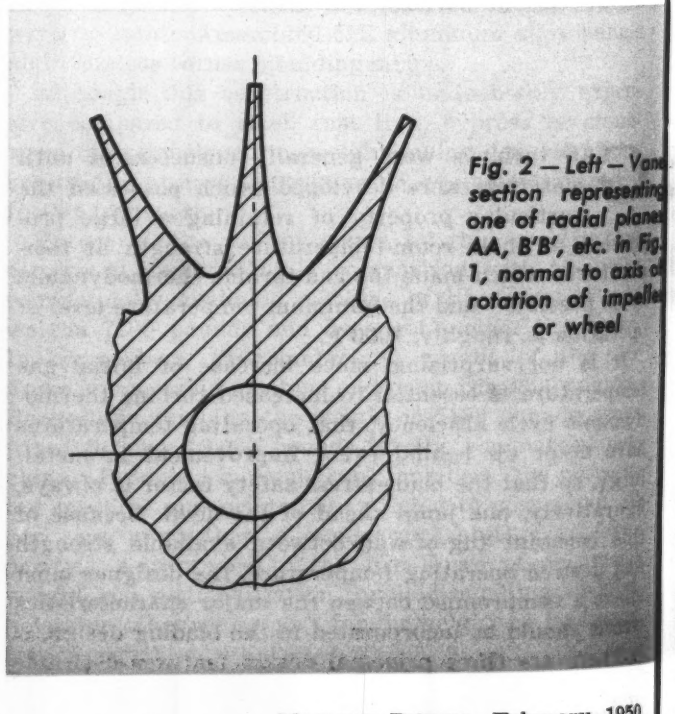


Fig. 2 — Left — Vane section representing one of radial planes AA, B'B', etc. in Fig. 1, normal to axis of rotation of impeller or wheel

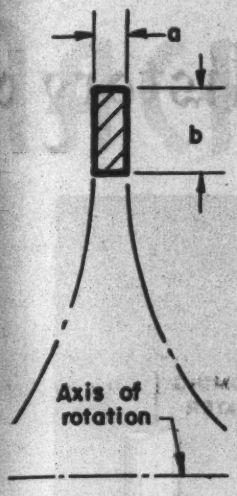


Fig. 3 — Left — Cross section of blade tip showing minimum tip thickness, a, extending radially for distance b toward axis of rotation

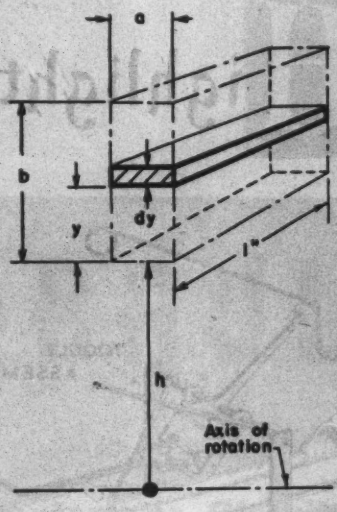
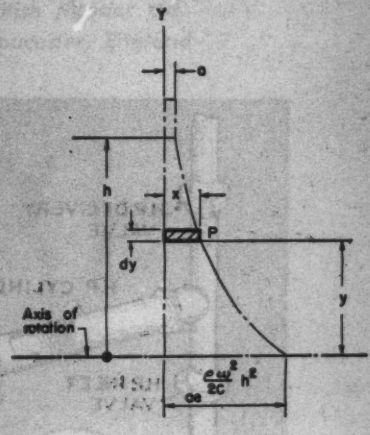


Fig. 4 — Right — Dimensions of strip used to determine centrifugal force due to vane tip

Fig. 5—Below — Dimensional notation used in derivation of equation for centrifugal force due to variable vane section



$$dF = dm\omega^2 y = -\rho x y \omega^2 dy$$

$$\frac{dF}{dy} = -\rho\omega^2 xy \quad \ldots\ldots (1)$$

But the stress at $P = F/x = C$ and is constant by hypothesis. Therefore $F = C\,x$, $dF = C\,dx$, and $dF/dy = C\,dx/dy$. Hence, from Equation 1

$$C\frac{dx}{dy} = -\rho\omega^2 xy$$

$$\frac{dx}{x} = -\frac{\rho\omega^2}{C}\,ydy$$

Differentiating,

$$\log_e x = -\frac{\rho\omega^2}{C}\frac{y^2}{2} + C_1$$

where C_1 is the constant of differentiation. Since $x = a$ when $y = h$,

$$\log_e a = -\frac{\rho\omega^2}{2C}\frac{h^2}{2} + C_1$$

$$C_1 = \log_e a + \frac{\rho\omega^2}{C}\frac{h^2}{2}$$

$$\log_e \frac{x}{a} = \frac{\rho\omega^2}{2C}(h^2 - y^2)$$

$$x = ae^{\frac{\rho\omega^2}{2C}(h^2 - y^2)}$$

$$x = a\frac{e^{\frac{\rho\omega^2 h^2}{2C}}}{e^{\frac{\rho\omega^2 y^2}{2C}}} \quad \ldots\ldots (2)$$

which enables the designer to plot the vane cross-sectional profile for constant maximum stress, C.

For interest in plotting the vane shape it may be noted that when $y = 0$,

$$x = ae^{\frac{\rho\omega^2}{2C}h^2}$$

From a practical viewpoint, blade failure from fatigue due to induced vibrations is much more to be feared than an outright failure due to overstress. This is true even if a high stress value is selected from the available high temperature stress-to-rupture curves of the material to be used. This is because the increased ductility at high temperature allows plastic flow of the material to take place at points of stress concentration so that local failure due to overstressing is much less likely to occur than at room temperature.

The author has designed supercharger turbine wheels which, if allowance were made for a normal stress concentration factor and for reduction of tensile strength due to operating temperature, were theoretically stressed locally up to the ultimate value of the material. The blades were machined integrally with the hub so there were no root fastenings to consider. Blade failure never occurred during the life of the units, which must be attributed to plastic flow reducing the local stress concentration.

A TOTAL thrust of over 15,600 lb from the most powerful jet engines in production in this country drive the Air Force's new XB-51 jet bomber which successfully completed its first flight recently. Built by the Glenn L. Martin Co., the bomber carries two of its jets mounted forward and below the wing and a third in the tail. General Electric Co. produces the engines at plants in Lynn, Mass. and Lockland, O. One of the unusual features of the plane is the location of the horizontal stabilizers, which are mounted in a "T-shape" fashion on top of the vertical stabilizer and fin in order to be as clear as possible from turbulence created by the wings and forward engines.

Highlights in the History o

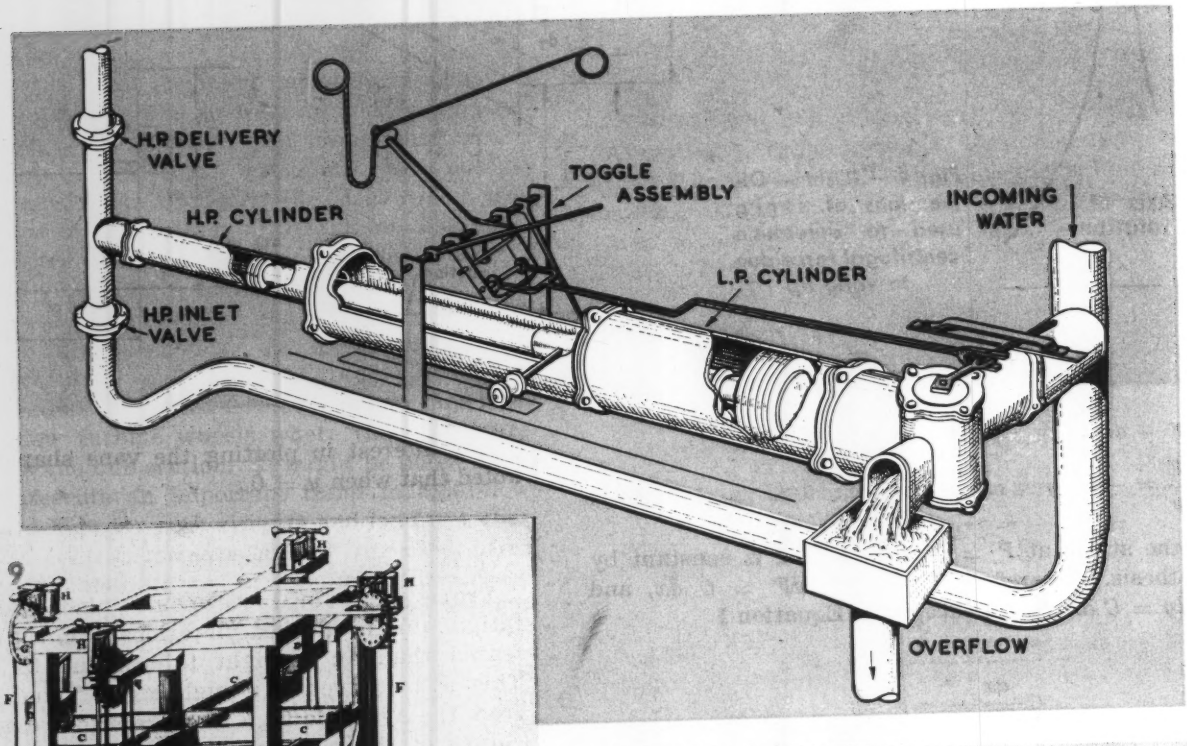
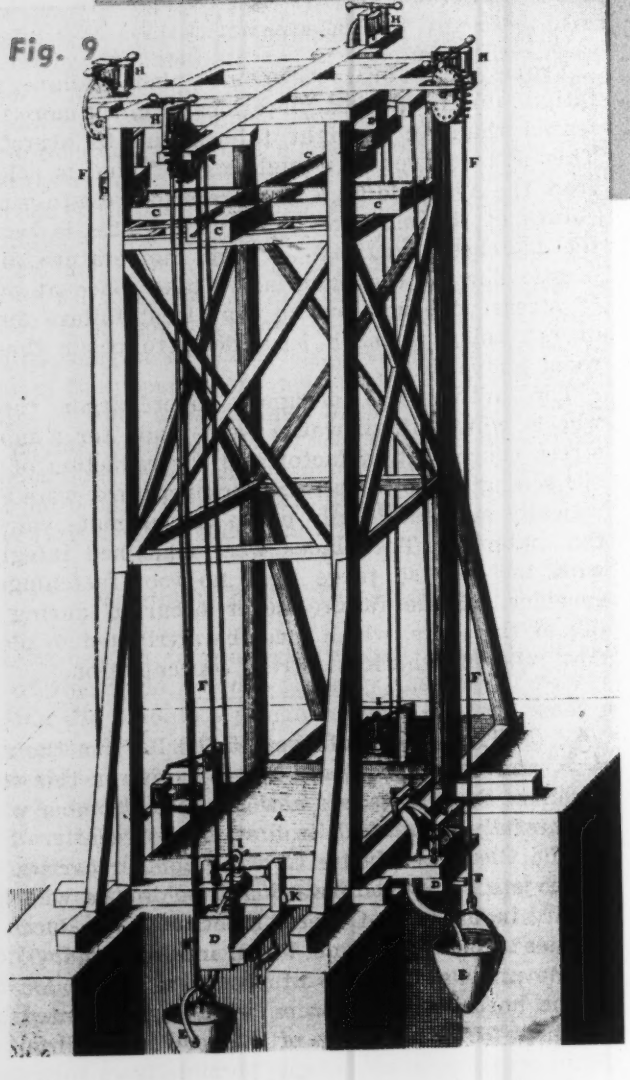


Fig. 9



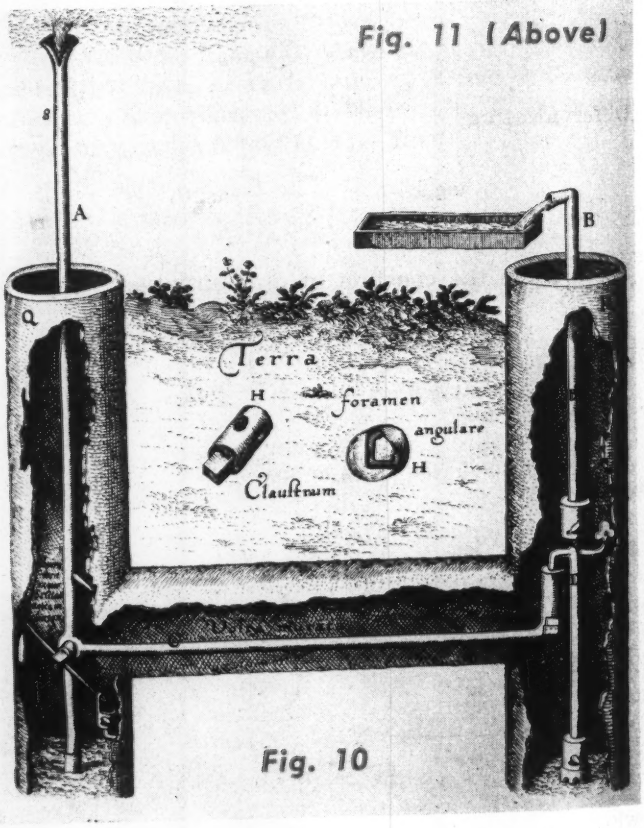


Fig. 11 (Above)

Fig. 10

MACHINE HYDRAULICS

By H. G. Conway
Technical Director
British Messier Ltd.
Gloucester, England

Part 4—Automatic Circuits

A VERY early automatic pumping system, attributed to Gironimo Finugio of Rome in 1616 and known as "gaining and losing buckets" is illustrated in *Fig.* 9. The device consists of a bucket at *D* which is raised to *C* by means of a corresponding drop of the other bucket, the object being to raise the level of some of the main water supply. Water is bled off from the main supply and fills the bucket *E*. This drops and raises the other bucket which has become filled either by a flap valve in its bottom, as in some constructions, or by a second water bleed, as in the one illustrated. The rising bucket is tipped over into the upper trough by a projection and then the descending bucket is tipped over by another projection or by virtue of its shape, and empties. The rising bucket is counterbalanced so that when both buckets are empty it descends and the cycle is repeated. A flywheel is geared to the pulley shaft to smooth out the action and make sure of positive action at the end of each stroke.

The modern hydraulic engineer will appreciate the sequence and automatic reversing actions.

A "pressure engine" described by Fludd (1618) is illustrated in *Fig.* 10. This ingenious system uses one water supply (which may be waste) to pump water from another (e.g., clean) source to an elevated level. The water from the pumping source enters at *A*, passes through a three-way rotary cock and lifts the piston in the pump cylinder. This discharges water already sucked from *D* out through the delivery at *B*. A bleed from the incoming water at *A* fills up a small container *G* and when the counterweight has been overcome, *G* descends and rotates the cock. This allows the pump piston to descend under its own weight and suck in a fresh supply of water through *D*, both *D* and *B* being fitted with appropriate flap valves.

As *G* descends it hits a projection which lifts a small valve in its base and allows the water in the container to escape. When this has escaped the counterweight takes charge and the cycle is repeated.

This ingenious system should command the respect of all hydraulic engineers. It has the elements of an automatic reversing system as used on machine tools, windshield wipers, etc. It shows the use of a rotary cock, a sequence system and a separator piston.

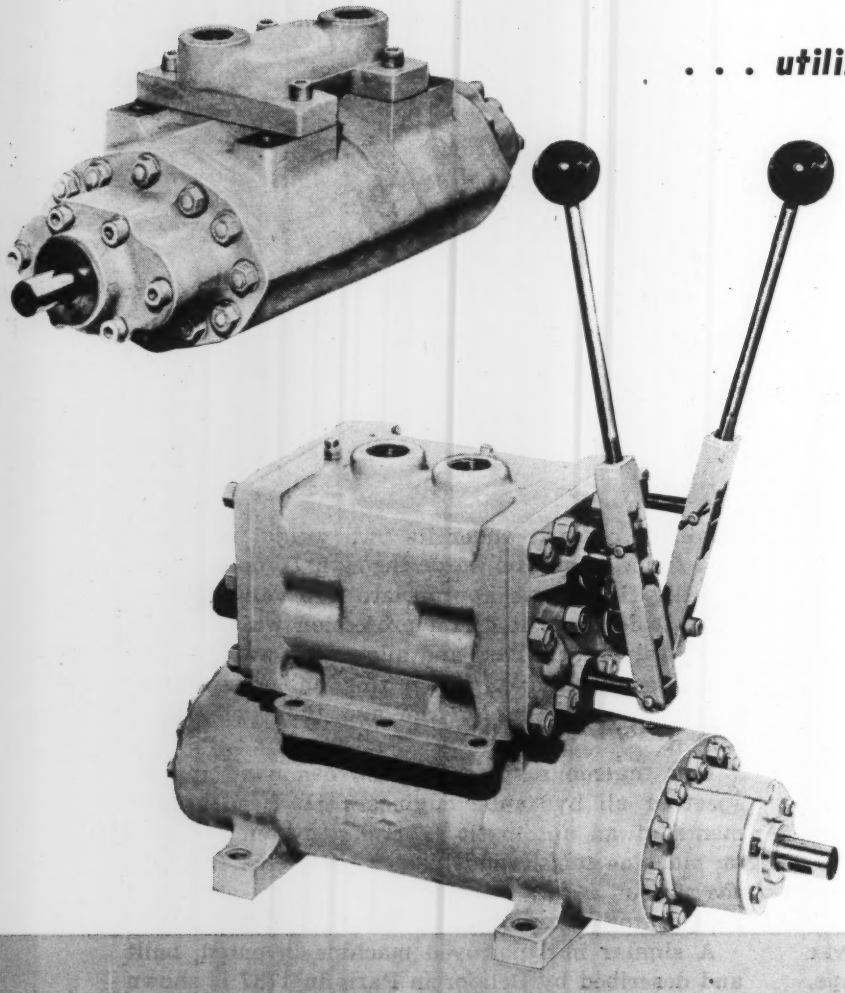
A similar but improved machine invented, built and described by Belidor in Paris in 1737 is shown in *Fig.* 11.

This machine is really of remarkable technical interest although it is not clear whether it proved reliable. The incoming water is connected to the outlet pipe and, flowing through the H.P. inlet valve, forces the piston assembly to the right if the cock controlling the larger cylinder is at exhaust. When the piston reaches its right-hand position it trips a toggle assembly which reverses the three-way cock and applies pressure to the larger cylinder. Thus the incoming pressure acting on the larger piston moves the pistons to the left, forcing out the water in the small cylinder up the delivery pipe to a height which is greater than that of the incoming water in the ratio of the piston areas. On reaching full travel the toggle trips again and reverses the valve and the cycle.

This machine illustrates the principle of the hydraulic intensifier, a quick-change valve gear and continuous reciprocation.

ROTARY PISTONS

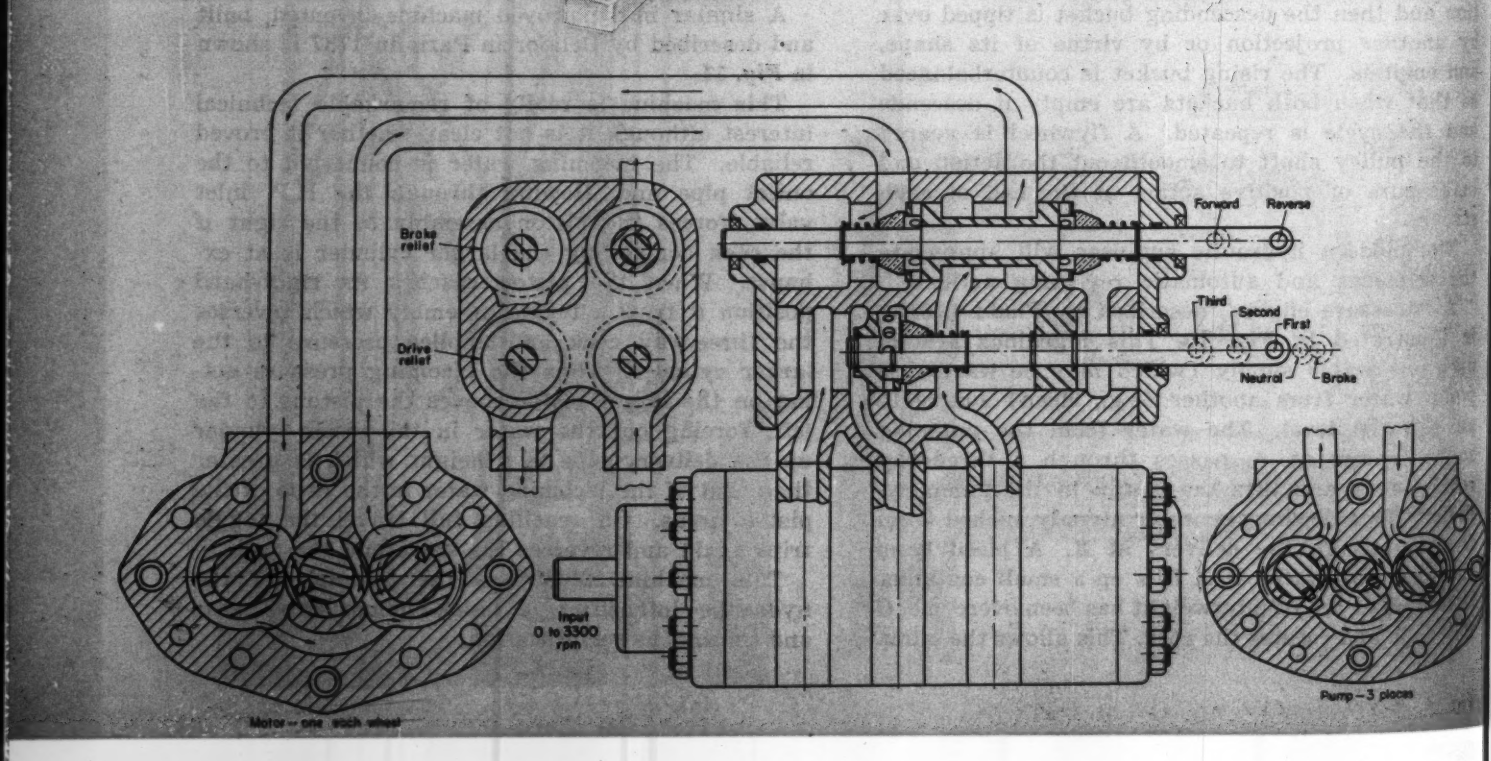
. . . utilized in new hydraulic pump design



By Roger W. Bolz
Associate Editor, Machine Design

ADVANCES in the field of machine hydraulics have generally been closely allied with the development of improved hydraulic components. Practical, economical and efficient units are a primary requisite for assuring the acceptance of hydraulic power transmission in lieu of older, more common alternates. Continuing efforts in this field have brought into sharp focus the manifold advantages to be obtained through the use of hydraulics, and modern equipment is rapidly expanding the applications in machines of all types.

One of the most recent developments in the hydraulics field is the hydraulic transmission system invented by Frank Berry



and now manufactured by Berry Motors Inc. Components of a typical transmission are shown in *Fig.* 1. Principal characteristics of the pump which is the basic unit of the transmission are utter simplicity, making for low cost, and virtual elimination of wearing parts. The general design character of the unit is readily apparent from the cross-sectional drawing of the transmission shown in *Fig.* 2. The circuit layout indicated is typical of a number now in successful operation on various types of machines.

Cross section of the pump at the right in *Fig.* 2 shows the primary parts. Two rotary pistons which are geared to and mate with a central rotary abutment constitute the heart of the unit. Supported by antifriction bearings, the abutment rotor and pistons rotate without frictional contact with any surface. Snug rolling contact is maintained between the cylindrical surfaces of the abutment rotor and both piston rollers. During that portion of the cycle when a piston mates with the abutment, ample clearances for the free flow of fluid are allowed between the parts. This unique rotary piston principle delivers continuous hydraulic power without shock or pulsations.

Manufacture of the major pump parts involves only ordinary drilling, boring, turning, gear shaping, cylindrical grinding and surface grinding operations with no special fitting or sizing requirements. Thus, exceptionally low initial cost is obtained. Added to this fact is the complete flexibility of the basic pump unit ordinarily termed "place". The units can be reversed merely by changing the direction of fluid flow and because of their symmetry can be used as either pumps or motors, *Fig.* 2 left. Only two lines and a four-way valve are necessary for reversal of a motor.

To multiply output, standard units or places are stacked together as needed in a common housing. Up to three places are regularly employed, *Fig.* 2, but four can be used if needed. This permits the operation, separately from one source, of different portions of a system or combinations of output controlled by means of interconnected valving. Output of a three-place pump can be automatically controlled by valving so as to be torque-demand responsive. Where high powers in confined spaces are required, two units or places are used back-to-back in a common casting. This provides an especially rigid structure in the most compact form possible to produce.

Design of the pump permits unusual flexibility for laying out systems. One pump place can be employed to drive one identical unit as a motor at the same speed or, by adding places to the pump, directly multiplied speeds can be obtained. The reverse is also true. One pump may be used to drive a three-place motor to obtain one-third the speed and horsepower and three times the torque. High velocity as well as pressure is utilized in driving the motors and generally velocities up to 30 feet per second are used although in several cases up to 60 feet per second has been employed successfully. Motor speeds up to 6000 rpm can be readily obtained. Through simple valving, variable-speed pumps can be used to drive a motor at constant speed. Such an arrangement is shown in *Fig.* 3.

Totally closed systems are recommended with these units and thus the problems of filtering and air breathers are eliminated. Synthetic oils are generally preferred and viscosities well above 400 SSU at 100 F

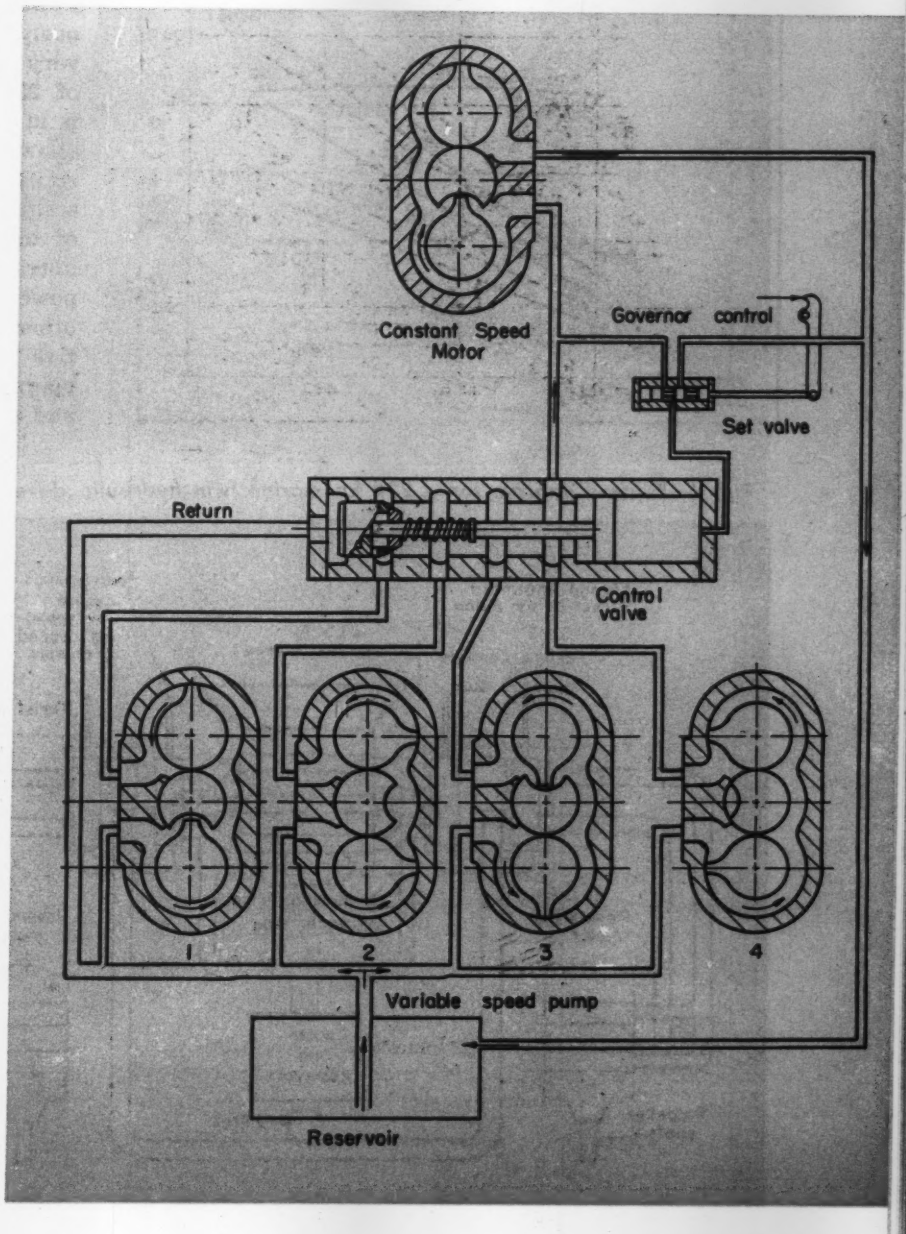


Fig. 1—Left above—Pump, manual controls and dual end-mounted motors for a typical transmission arrangement

Fig. 2—Left—Diagram of tractor transmission system of Fig. 1, showing motor and pump sections and cross section of valve

Fig. 3—Right—Diagram of system arranged for driving a motor at constant speed

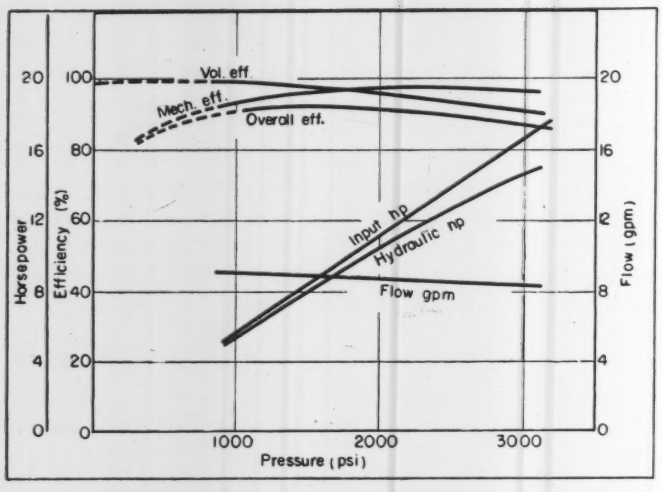
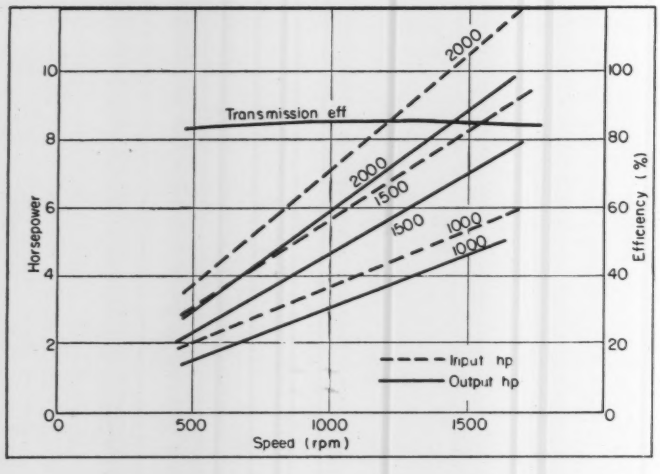


Fig. 4—Above—Operating characteristics for a single-place 1400 CH pump operating at 1750 rpm

Fig. 5—Below—Operating characteristics of a typical transmission system at several pressures



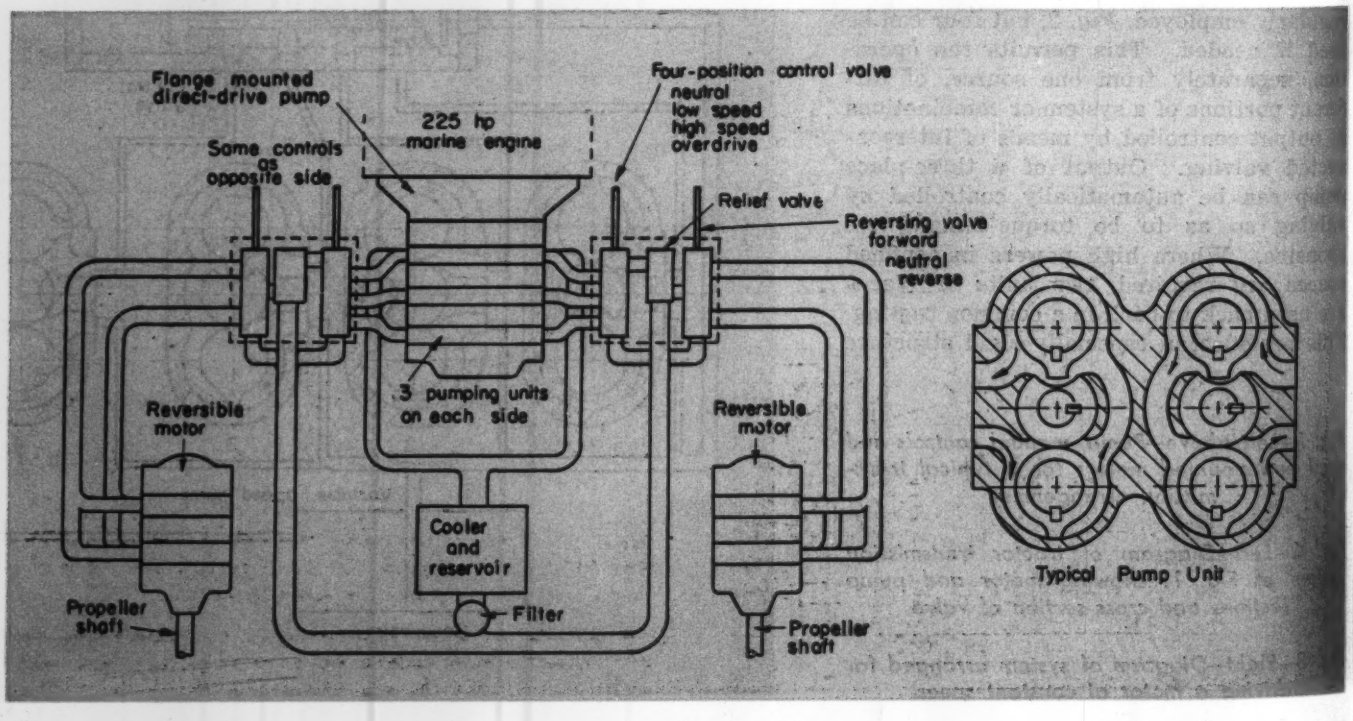
give satisfactory service. Action of the pumps being continuous and flow being smooth and uninterrupted results in almost noiseless operation. Pressures up to 3000 psi can be obtained for continuous-duty performance with long life. With noncontinuous-duty systems, pressures up to 5000 psi and occasionally up to 6000 psi are possible. Efficiencies in operation are exceptionally good and are the same for either direction of operation. The chart in *Fig.* 4 shows the operating characteristics for the typical single-place pump. That for a typical transmission system is shown in *Fig.* 5.

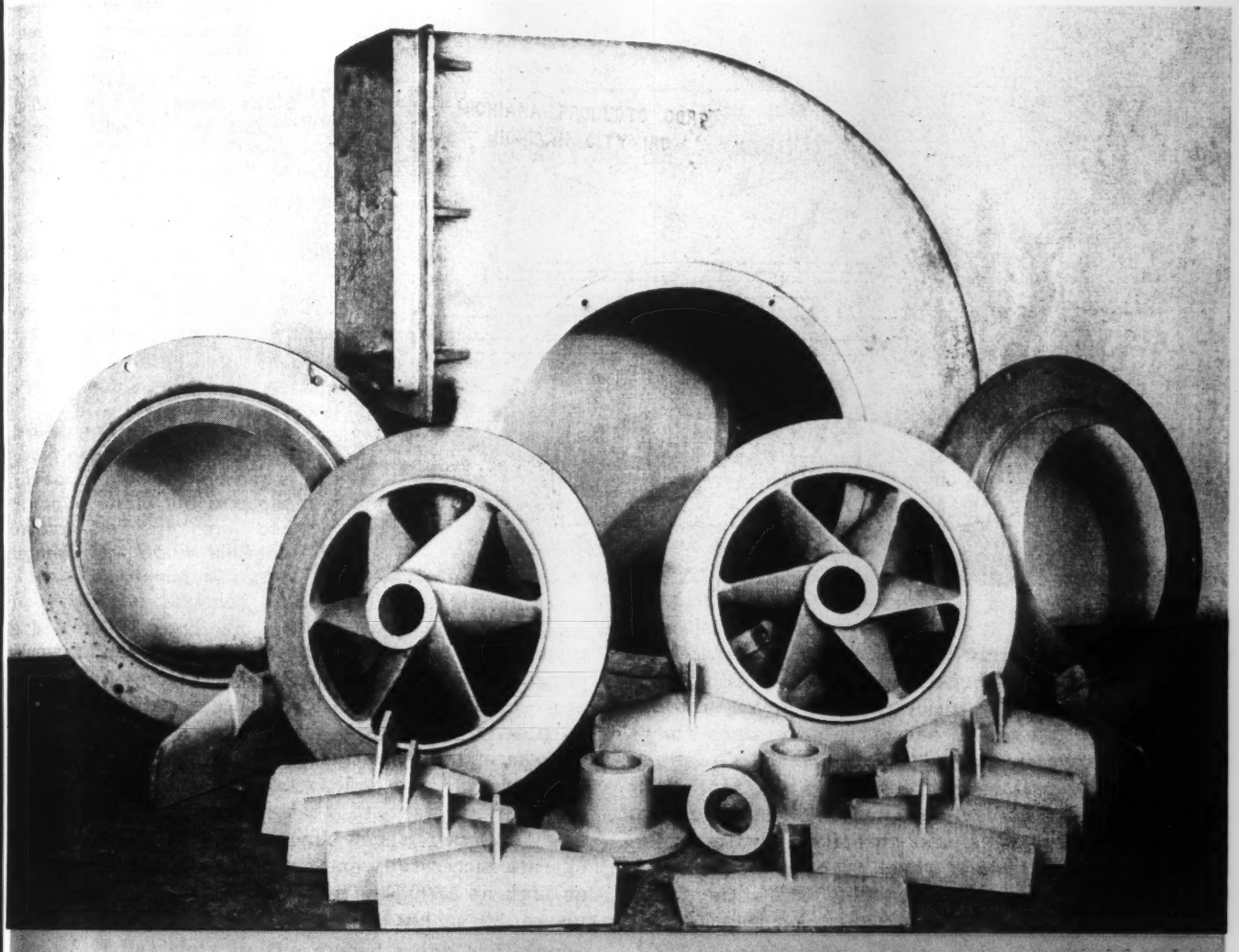
The overall possibilities on hydraulic horsepower are pushed far beyond today's common limitations. Typical standard Type 1400 CH pumps operating at 1750 rpm and 3000 psi provide the following characteristics:

Displ. (gpm)	**Places**	**Hp**	**Torque** (ft-lb)
9	1	15.74	47.2
18	2	31.48	94.5
27	3	47.22	141.7

Power of special units, however, is not limited seriously. Special units can be made for application in very high power ranges. A marine transmission drive of 250 hydraulic horsepower has been installed and is in operation. Flow diagram for this installation is shown in *Fig.* 6. Now in process is a still larger transmission of 1000 horsepower which, when installed and in operation, should provide a great deal of important and useful data in this relatively new, untried field of high-power, high-pressure hydraulic power transmission. In the practical offing is another unusual transmission—an automatic automotive drive—based on a test unit which has been in operation and on test on a rail car for over a year and a half.

Fig. 6—Below—Diagram for a 225 hp marine twin hydraulic drive. Three places give three different speed ratios

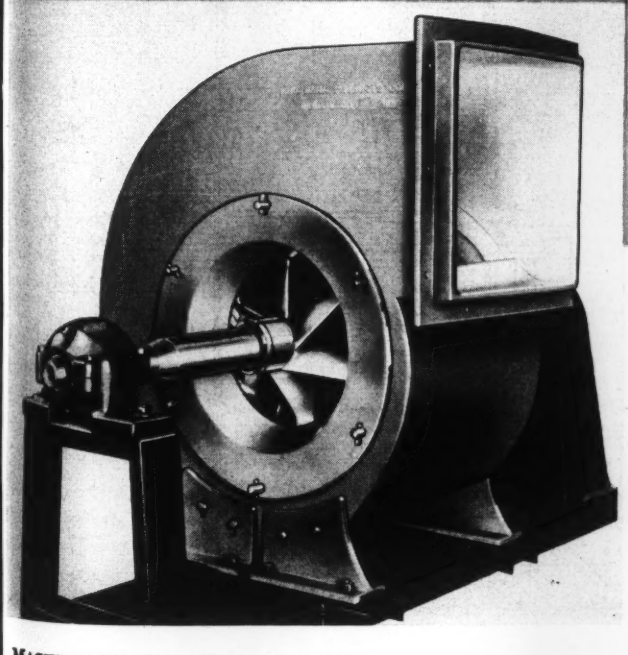




High-Temperature Fans

. . . employ unique design features to obviate the unbalancing effects of expansion

By Herbert Chase



UNTIL recently, the design of centrifugal fans has limited their use to maximum temperatures of about 1200 F, even when so called "high-temperature" types are employed. This limita-

Fig. 1—Above—These stainless steel castings, produced in the Michiana foundry, are used in building a double-inlet fan of the same make

Fig. 2—Left—Michiana high temperature double-inlet fan as it appears when assembled on a temporary base without the end water coupling

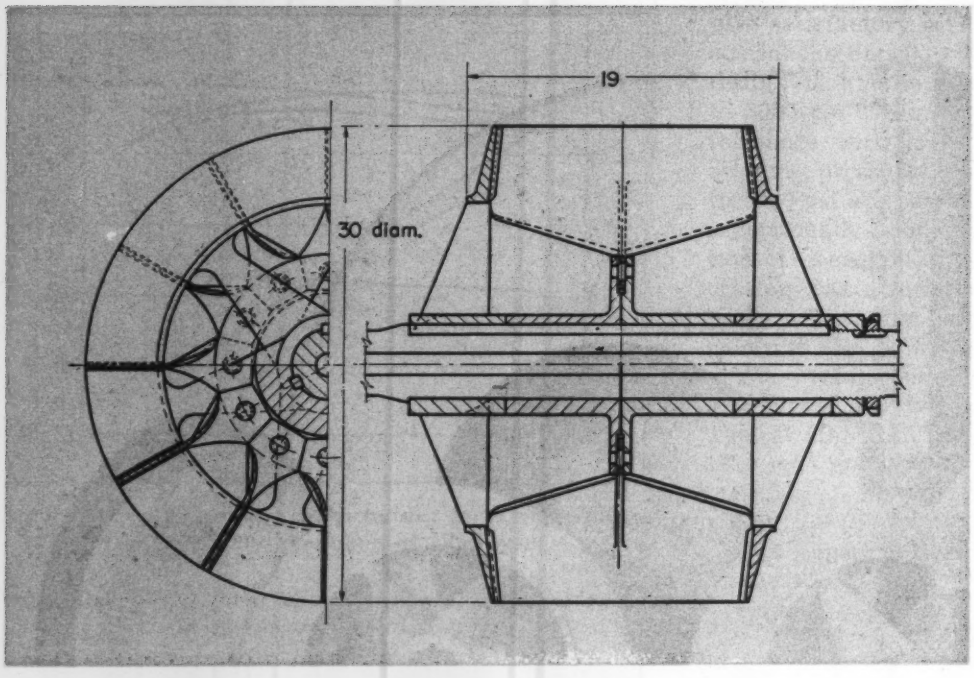


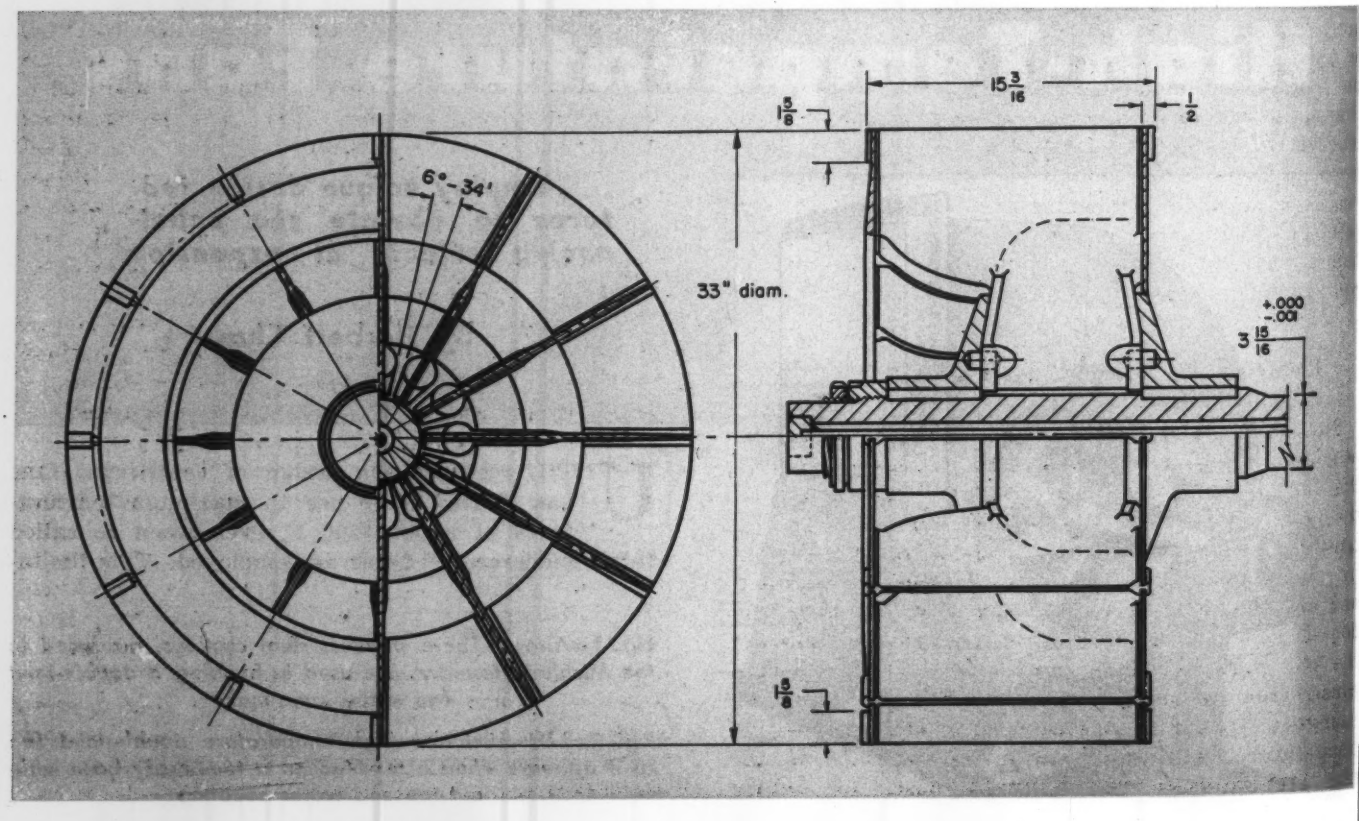
Fig. 3—Left—Wheel assembly for 30-inch double-inlet fan. A single pin anchors each blade to hub flanges but blade edges rest in radial slots in the end rings

Fig. 4 — Below — Single-inlet wheel assembly. Each blade is anchored to hub flanges by two pins but blade edges fit end ring slots. This structure does not distort with changes in temperature

tion has applied largely because conventional design calls for sheet-steel construction and, even when heat-resistant stainless sheets are employed, rotors tend to warp and to go out of balance when they attain temperatures above 1200 F.

These considerations not only have placed limits upon fan design but have affected also the design of high-temperature ovens and furnaces because fans could not be employed if gases to be circulated attained temperatures above that for which the fans were designed. In certain instances, furnaces of some types required a length three times that which would have sufficed if fans capable of running at temperatures well above 1200 F had been available for this purpose.

To meet this situation, Michiana Products Corporation, one of whose departments specializes in steel castings resistant to heat, corrosion and abrasion, has developed a new line of centrifugal fans that operate successfully and continuously at temperatures as high as 1800 F. These fans are made with rotors up to 30 inches diameter and in either single or



double-inlet types with capacities up to 25,000 cubic feet per minute.

Because all steels are subject to creep in the temperature range for which such fans are designed, and centrifugal force increases with the square of the speed, maximum speed allowable depends upon the maximum temperature and upon the creep characteristics of the steel at this temperature.

Cast construction has been chosen not only because it fits the manufacturing facilities available but because, among other important reasons, a one-piece housing can be employed, *Fig.* 1. Shapes of rotor parts chosen are such that they can be cast and assembled readily without using screws, bolts or rivets and without welding. These are most important considerations because satisfactory performance is dependent in large measure upon having parts that can expand and contract with temperature changes and still retain their shape and their relative position within limits that do not alter the dynamic balance of the rotating assembly.

A typical double-inlet fan assembled from the set of stainless steel castings of *Fig.* 1 is shown in *Fig.* 2. To resist the imposed loads, a single pin anchors each blade through an integrally cast ear or flange in the central plane and at right angles to the fan axis and to the face of the blade. The machined ears of the blades fit between the circular flanges of the hub castings, *Fig.* 3, and through each is fitted a ¾ by 1-inch diameter stepped pin. With this arrangement, the pins cannot move axially and are loaded only in shear. All centrifugal forces are taken by the pins which effectively prevent any possibility of blades moving radially.

Tapered side edges of the blades are machined to fit with 0.001-inch clearance between the side faces of radial slots in the dished rotor end rings, *Fig.* 3. Spokes of the end rings have helical surfaces which act as assist inlet blades. Although edges of the fan blades are supported in the radial slots, the blades can expand and contract with temperature changes without binding or distortion and without tending to distort mating parts. Similarly, dimensional changes in the supporting hub flanges and side rings, occasioned by temperature changes, cannot result in binding or distortion such as to affect dynamic balance of the rotor as a whole. This, of course, is the important objective of the design.

Recessed Pins Used on Double Inlet Fan

Single-inlet wheels are generally similar in design, as shown in *Fig.* 4, but the side rings are separate and the hub flanges are spaced farther apart than in the double-inlet wheel. Each blade has a radial extension that fits between the flanges and is retained by two anchor pins. Pins are completely recessed and are subjected only to shearing stress, as in the double-inlet fan. End rings have slots that support the side edges of blades but, as in the other design, construction is such that no binding, distortion or change in dynamic balance occurs with changes in temperature. All rotor elements except blade anchor pins are stainless steel castings chosen for ability

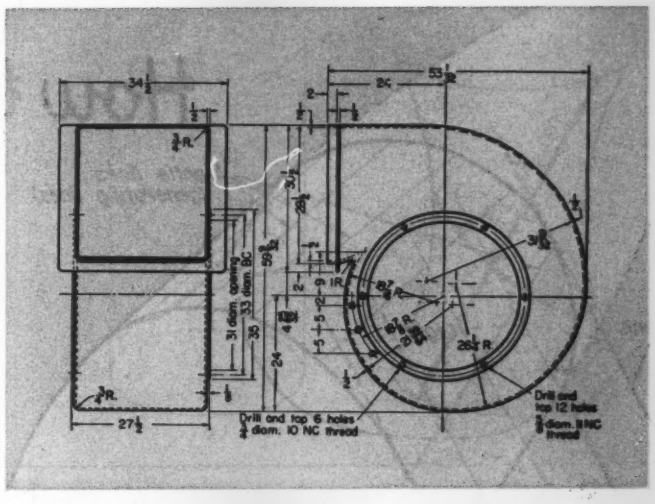


Fig. 5—Stainless steel cast housing for a 30-inch double-inlet fan. Sections throughout are substantially uniform

to resist the effects of high temperatures without significant deterioration. If required, alloys that are also resistant to abrasion can be employed.

Although the shaft does not come in direct contact with the hot gases that pass through the fan, heat is conducted to the shaft via the highly heated castings that the shaft supports. For this reason, the shaft is drilled to provide a central channel for water cooling. This permits the use of ordinary cold-rolled steel shafting and, of course, keeps shaft journals and the V-belt drive pulley at safe working temperature.

Since the fan housing attains approximately the same temperature as the rotor parts, it too is cast from the same alloy, Zorite. This is a general-purpose alloy containing 35 per cent nickel and 15 per cent chromium. If sulphurous atmospheres are involved, No. 100 alloy contained 12 per cent nickel and 25 per cent chromium is employed. Where a combination of corrosion and abrasion resistance is required, Fire Armor B alloy, containing 60 per cent nickel and 13 per cent chromium is recommended. Housings, although large, are cast in one piece with a substantially uniform section of ½-inch. Little machine work is required beyond a number of drilling and tapping operations, *Fig.* 5.

Since there is no direct connection between the fan wheel and the housing, their relative positions depend upon foundation supports for the pillow blocks and housing. These, of course, are determined by the particular installation arrangements and slight variations in foundation alignment that occur with changes in temperature do not sensibly affect fan performance.

Largest single installation to date has been in a foundry where fourteen fans, with 18 to 30-inch wheel diameters are in use in furnaces for stress relieving castings at 1425 F. Other installations include one for an annealing furnace in a tube mill where a 30-inch fan running at 1020 rpm delivers 18,000 cubic feet per minute at 1675 F, and another for a 68-inch strip annealing furnace operated at temperatures up to 1820 F.

How to design economical SHEET-METAL

By Dr. Ing. Hans Schmidbauer
Augsburg, Germany

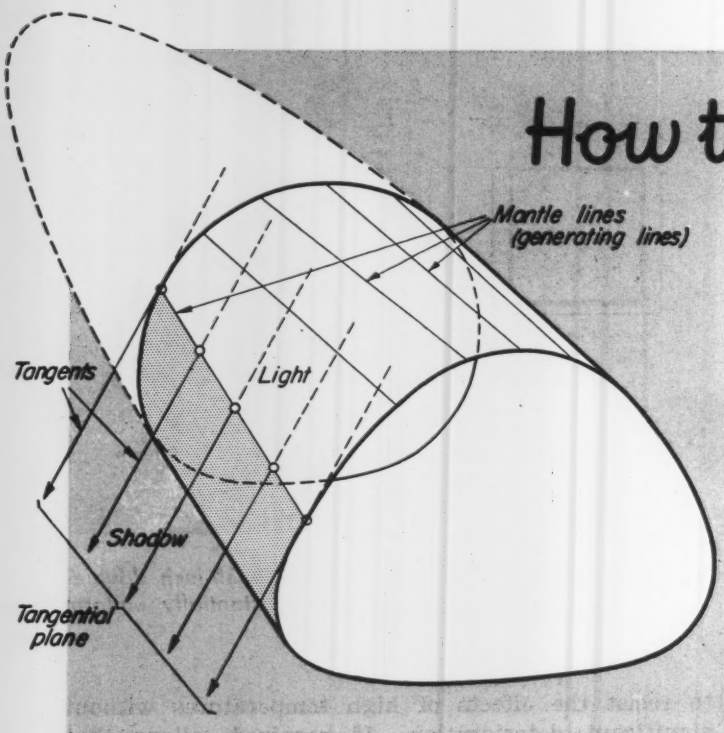


Fig. 1—Part of fuselage of Messerschmitt Me 262 jet fighter. The sheet-metal section shown by the heavy lines is developable when bent to shape on the mantle lines

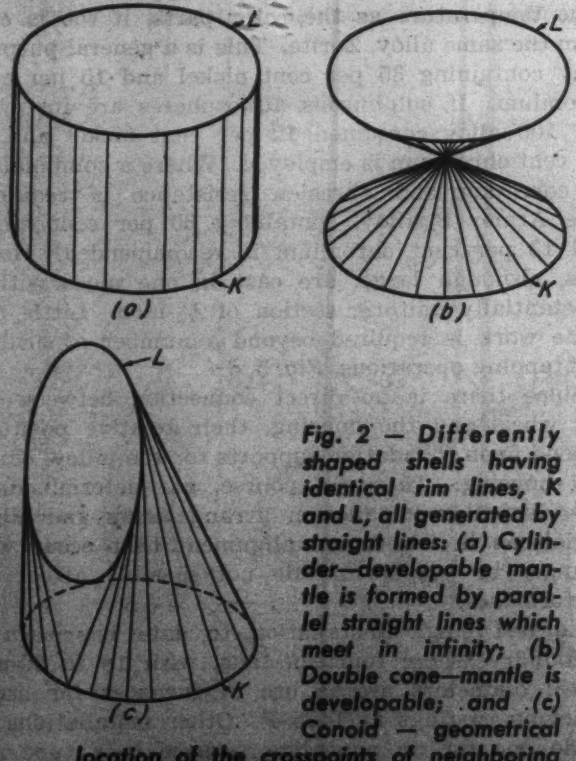


Fig. 2 — Differently shaped shells having identical rim lines, K and L, all generated by straight lines: (a) Cylinder—developable mantle is formed by parallel straight lines which meet in infinity; (b) Double cone—mantle is developable; and (c) Conoid — geometrical location of the crosspoints of neighboring generating straight lines is any spaced curve (surface is not warped, but developable)

GENERATION of spherically curved sheet-metal shells requires expensive tools. To reduce costs, spherically shaped surfaces should be replaced by developable ones as far as circumstances permit. Thus, knowledge of the rules of developability is most important wherever formed sheet-metal casings or housings are required. An example is the jet fighter fuselage section of *Fig.* 1, which is neither a cylinder nor a cone. The following exact and simple graphical method developed by the author eliminates troublesome approximate solutions. It was applied with outstanding success at the Messerschmitt AG aircraft factory in the design of fuselages and windshields.

Curved surfaces are developable when they can be unbowed into a plane without tears and folds. There are three kinds of such surfaces: Cylinders (with parallel straight generating lines, *Fig.* 2*a*); cones (generating straight-lines cross at one finite point, *Fig.* 2*b*); and conoids (geometric location of the cross point of neighbored generating straights is any line, *Fig.* 2*c*).

Bowed surfaces are not developable when their curvatures are spherical. Examples of such shapes would be: Spheres, ellipsoids, paraboloids, etc. In all such cases, the shells would burst upon unbowing.

A striking distinction between these two main types of shells is found in the nature of their contact with a plane. Spherical shapes touch at a point, while developable shapes touch at a straight line

SHAPES

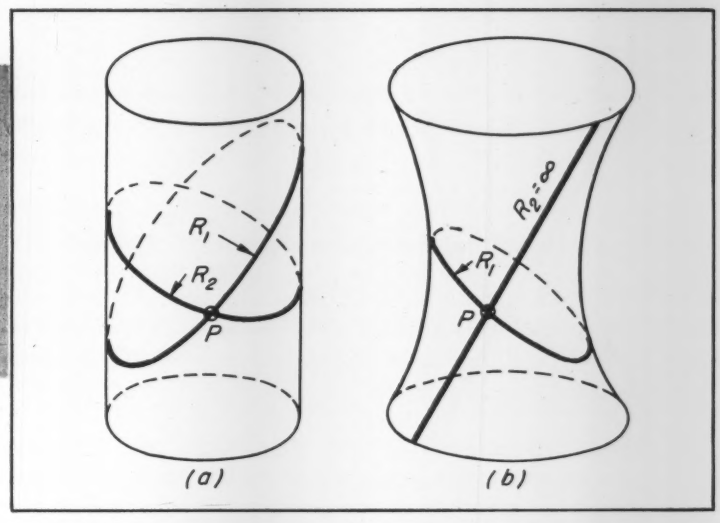


Fig. 3—Above—Double or single-curvature is no criterion of developability. The pseudo double-curved cylinder is developable; the pseudo single-curved saddleface is not

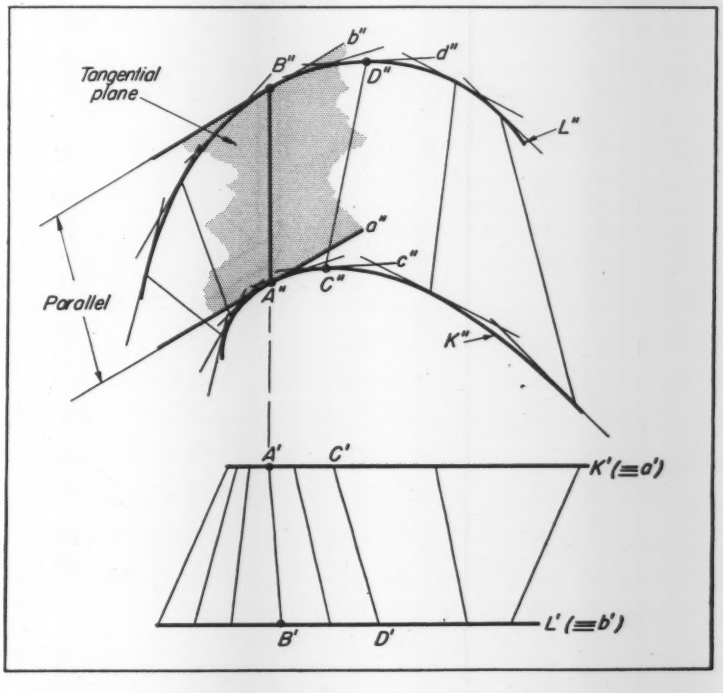
(also called a generating or mantle line). On developable surfaces, mantle or generating lines may be understood in what follows always to be straight. This quality for a given shape can be tested by rolling a solid model of the shape on a plane plate or by illuminating it from one direction to create sharply defined shadows, *Fig.* 1. The sharp boundaries of shadow and light (isophotes) locate the generatrices and provide the best means to comprehend the following constructions.

Determining Developability by Layout

Of course, the designer cannot use this simple test at the outset to check the developability of a surface inasmuch as the solid form does not exist. And so there is the question, how can a developable surface be designed? At first there exist only boundaries (rim lines or leading lines) of the surface, which give no hint as to the character of the curvature. The terms "double" and "single-curved" can be misleading. For example, *Fig.* 3 shows a pseudo double-curved but developable cylinder (a) compared with a pseudo single-curved hyperboloid (b) which is not developable. Furthermore, *Fig.* 2 shows that boundary curves of identical shape, *K* and *L*, do not indicate that the shell shapes will always be the same. Therefore, the question is how to locate the generating straight lines when the surface is given by any leading lines (rim lines). Of course, the last aim of these constructions is not the lines themselves but their use as "helplines," e.g., to find the intersection of the surface with other lines or surfaces.

As *Fig.* 4 shows, mantle lines are obtained by drawing-in a series of planes which are tangential to the rim lines *K* and *L*. The construction consists of enveloping the lines *K* and *L* with pairs of parallel straight lines (*a* and *b*, *c* and *d*, etc.)and drawing straight lines between the tangent points (A-B, C-D, etc.). To test the curvature of the model at the shop, it is not necessary to plot any curved auxiliary sections other than the two rim lines. All that is required is that the drawing contain a sufficient number of mantle lines to show the modelmaker where

Fig. 4—Below—Construction of mantle lines A-B, C-D, etc., when rim lines K and L lie in parallel planes. Tangential plane touches the bowed face at a straight line, which is the mantle line



to put his straight edge on the model to test its shape. Correctness of the curvature can be checked further simply by rolling the model on a color-stamped surface plate.

Some designers distribute the generating lines at equal distances (*n* and *m*) along the rim lines, as in *Fig.* 5. This method is absolutely wrong because it generally results in a solid having more or less a saddle face (*Fig.* 3*b*) instead of a developable mantle. Of course it is possible to construct the true unrolled mantle by cementing together numerous strips, but this method cannot be recommended because the continuous substitution of straight segments for bowed elements delivers an inexact result. It is better and

simpler to represent the mantle by enveloping a solid model with a paper sheet and tracing the boundary upon it. The model consists simply of two properly spaced flat patterns of wood, cardboard, etc., representing the rim lines, *Fig.* 6.

How Intersecting-Line Shape Is Found

To determine graphically the contour of the line at which two intersecting developable shells meet requires that a number of intersecting points be established which define the joint line. Part of the procedure by which these points are located is shown in *Fig.* 7. In this case the location of the vertical plane in which line *S-S* lies is known with reference to the shell, as is the angle of the line as depicted in the lower view. Thus, this line is drawn across the shell (top-view) and projection lines are dropped from the points of intersection with the mantle lines to the corresponding mantle lines in the elevation. In this manner the shape of the line created by the cutting plane is developed in the elevation. Final step is to project point X' up to the top view and thus establish the location of X''.

This principle is used in defining the contour of the line which joins the windshield and fuselage sections shown in *Fig.* 8. It will be noted, however, that the windshield shell of *Fig.* 8 has rim lines, K_w and L_w, which lie in *nonparallel* planes. In such cases, drawing in the straight-line pairs which locate the end points of the mantle lines requires a different technique than that employed when K and L lie in parallel planes. The technique for nonparallel planes is shown in *Fig.* 9.

Referring first to the three-dimensional sketch, *Fig.* 9*a*, it will be seen that the nonparallel planes K and L intersect along a straight line, S. Like these two rim-line planes, the straight-line pairs A and B, C and D, etc., must also be nonparallel. They meet, as shown, at cross-points (S_{ab}, S_{cd}, etc.) which lie on the

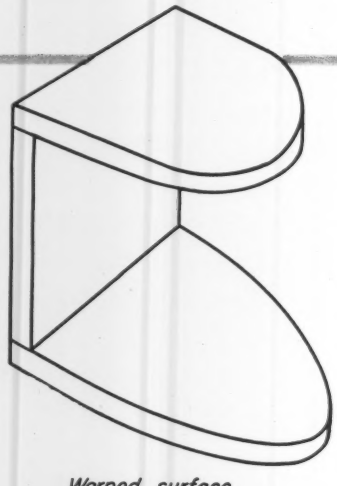


Fig. 5—Below — Wrong construction of mantle lines. Rim lines are divided into equal parts, m and n, corresponding points A and B being connected by straights. Resulting form would have saddle face

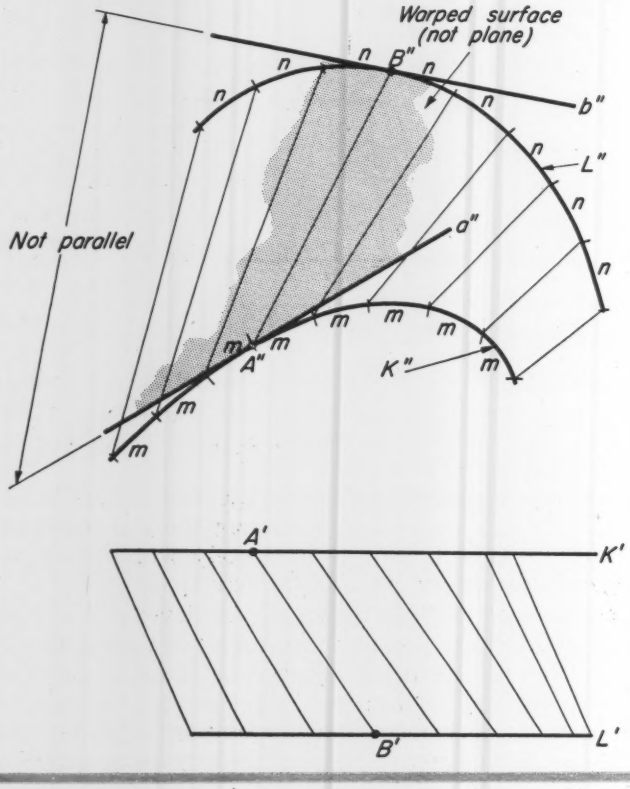
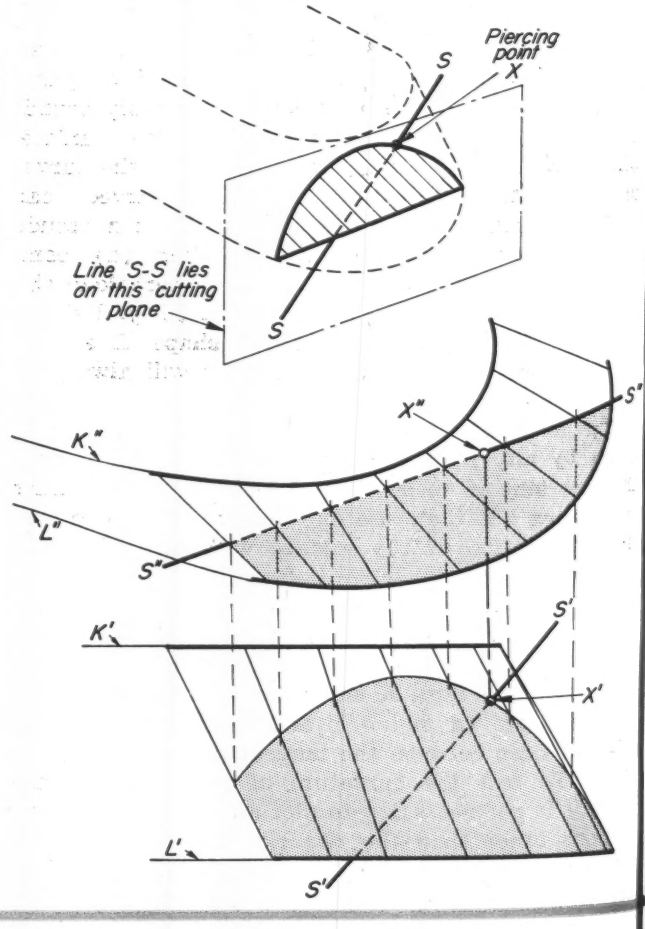


Fig. 6—Left—Model of developable shape can be made of two properly shaped and spaced flat patterns of wood, cardboard, etc., which represent the rim lines

Fig. 7—Below—Method for locating the crosspoint, X, of any straight line, S-S, with a developable surface



straight-line intersection of the K and L planes. *Fig.* 9*b* illustrates the construction as it is employed in conventional orthographic projection.

Using the principles illustrated in *Figs.* 7 and 9, the joint line of *Fig.* 8 is readily defined. First step is to locate and draw the mantle lines of the windshield shell. As in the example of *Fig.* 9, rim lines K_w and L_w are extended to their crosspoint, S. Having established this junction line, straight-line pairs, a and b, c and d, etc., can be drawn in on the top view, and the mantle line, n, established. Next step is to determine where mantle line n pierces the fuselage shell. To do this requires first that mantle lines be drawn on the fuselage form, the procedure shown in *Fig.* 4 being used inasmuch as its rim lines, K_f and L_f, lie in parallel planes.

Up to this point the layout looks like view (a) of *Fig.* 8, wherein all that is known about piercing point x is that its location on the fuselage shell must be coincident with some point along mantle line n. Thus, if a curve can be drawn on the fuselage form of the top view, the elevation projection of which will coincide with mantle line n, the point at which it crosses the mantle line in the top view will be the piercing point, x. Defining this curved line simply requires projecting the intersecting points of the fuselage mantle lines and mantle line n up to the corresponding mantle lines of the top view. The points thus established in the top view are joined by a line to form the curved line d-e. Crosspoint x then is projected down to mantle line n of the elevation. By drawing in a series of mantle lines on the windshield form and following the procedure described to locate a series of piercing points, the contour of the windshield fuselage joint line is established without undue difficulty.

More difficult than the foregoing problems is the case in which the rim lines K and L are each bowed in three directions. It occurs very seldom and can usually be avoided by choosing simpler conditions. The method for locating the mantle lines is somewhat similar to that employed when K and L lie in

Fig. 8—Right—Part of an airplane fuselage with windshield, showing the intersection between these two developable surfaces. Determination of joint-line contour involves locating intersection points, x, of the windshield generating lines with the fuselage surface

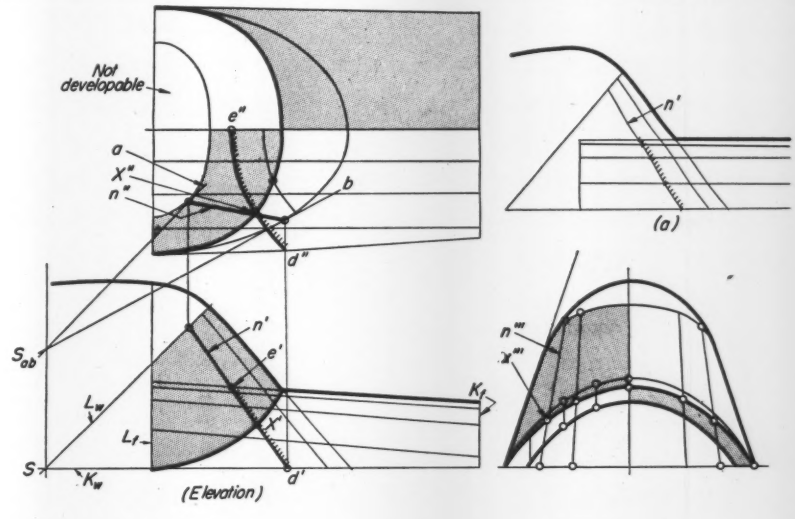
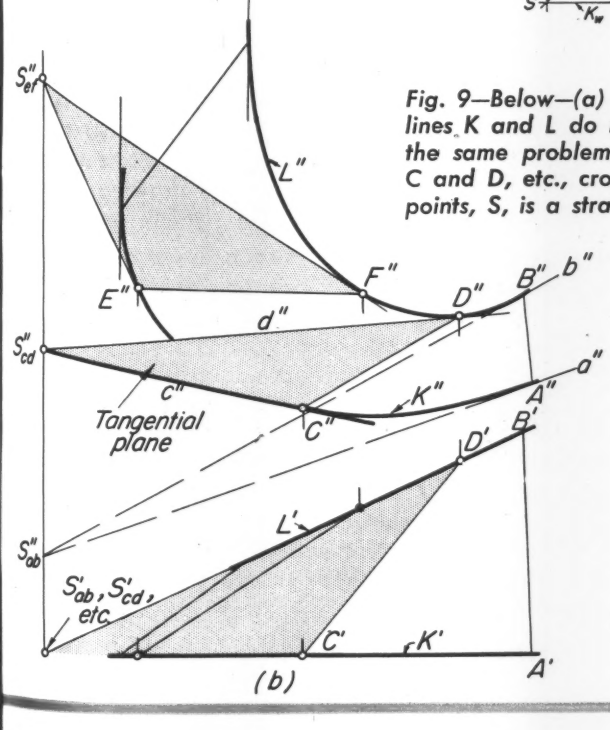
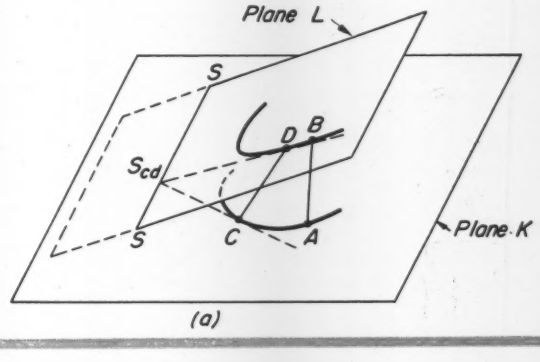


Fig. 9—Below—(a) Construction of mantle lines A-B, C-D, etc., when leading lines K and L do not lie in parallel planes. (b) Orthographic projection of the same problem; tangents a, b, etc., of corresponding points A and B, C and D, etc., cross at points S_{ab}, S_{cd}, etc. The geometrical location of all points, S, is a straight line which is the intersection of plane K with plane L





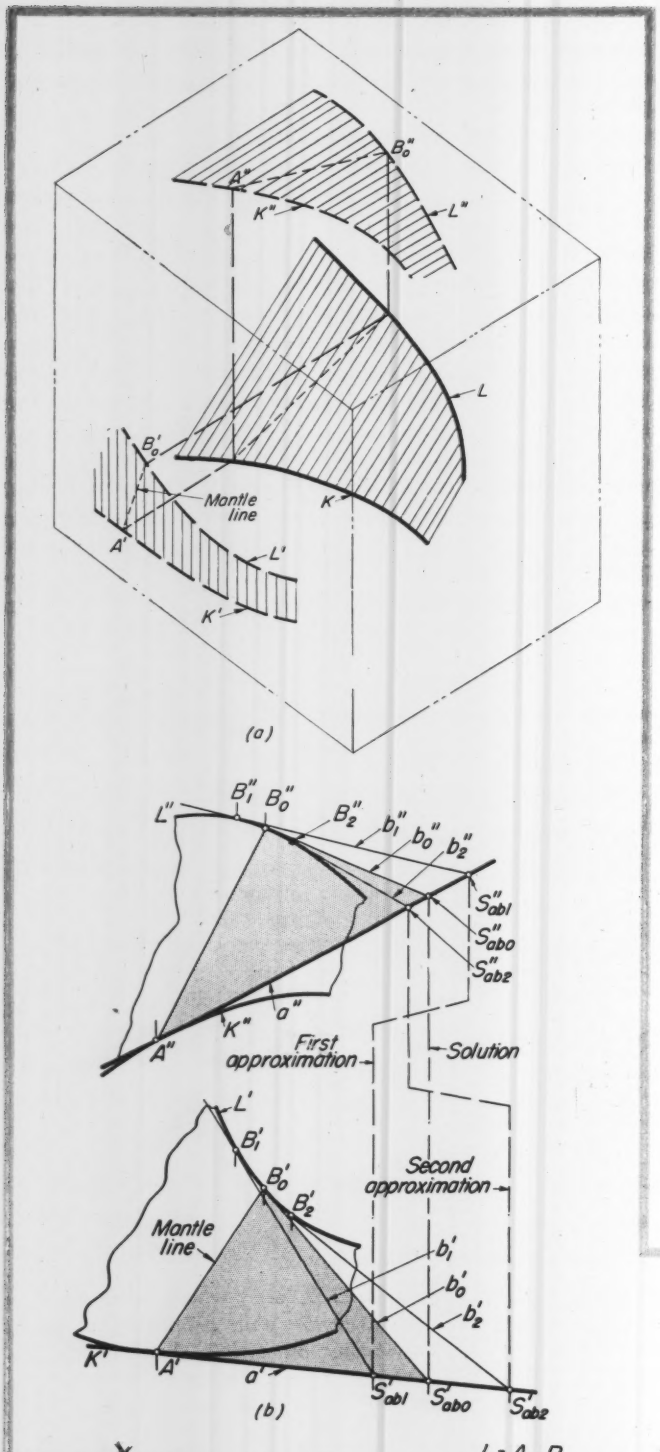


Fig. 10—Above — (a) Rim lines K and L are curved in two planes. Mantle line A-B_o is found by approximation. (b) Method involves sliding tangent lines b′ and b″ along L′ and L″ until crosspoints S'_{abo} and S''_{abo} are in vertical alignment. Points of tangency on the rim lines are joined to form the mantle lines

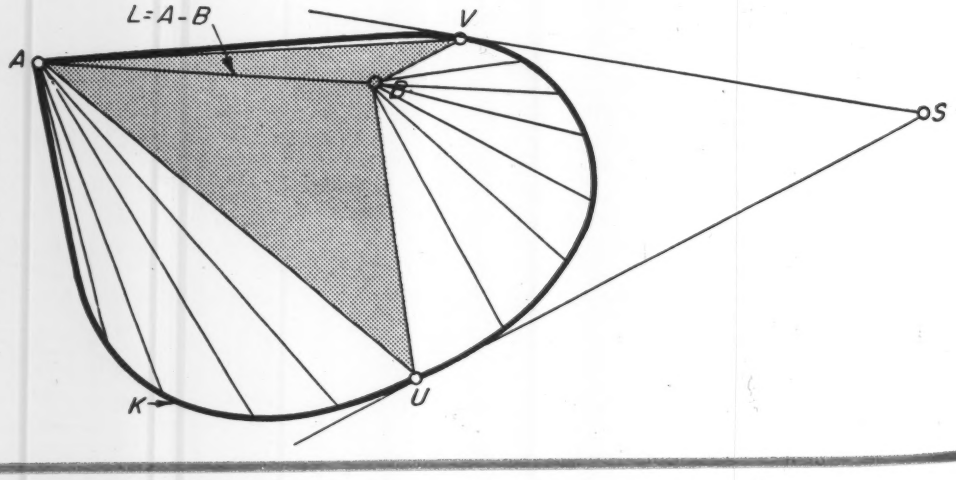
nonparallel planes. It necessarily differs, however, inasmuch as the double-bowed rim lines lie on numberless instantaneous planes each set at a different angle. The only practical way of locating the mantle lines is by a method of approximation.

How Approximation Method Works

Referring to *Fig.* 10, the three-dimensional view (*a*) shows how two double-bowed rim lines might actually appear in space, while the conventional orthographic views (*b*) show the same lines and the method used to locate their mantle lines. The procedure is as follows: A point, *A′*, is chosen on *K′*, and its tangent, *a′*, is drawn. Similarly a point, B'_1, is chosen on *L′* and its tangent, b'_1, is drawn to point S'_{ab1} where it intersects tangent line *a′*. Next, on the top view a point, *A″*, is projected onto *K″* from the bottom view, and its tangent, *a″*, is drawn. Then point B'_1 is projected vertically up to B''_1 on *L″* in the top view. A tangent, b''_1, is drawn from point B''_1 to tangent line *a″*, the intersection occurring at point S''_{ab1}. Inasmuch as points S'_{ab1} and S''_{ab1} do not align vertically, further approximations must be struck until alignment of these points is achieved. Actually, this is not particularly difficult. Lines *a′* and *a″* remain untouched, and only tangent lines *b′* and *b″* are changed on *L′* and *L″* until the required relationship is established. The last step, of course, is joining points *A′* and *B′*, and *A″* and *B″* to create the mantle lines.

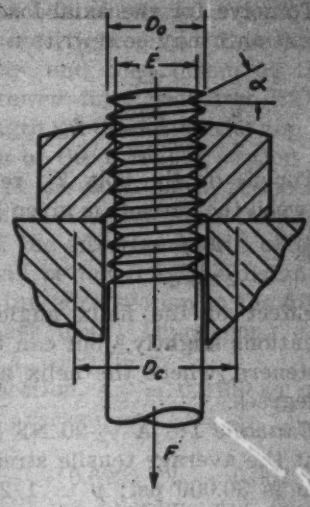
Developable surfaces are defined not only by pairs of curved rim lines but also by couples of straight rim lines, by straight and curved rim lines, and by single points coupled with rim lines. It is helpful to remember that every corner (single point or end of a rim line) produces at least a part of a cone. Furthermore, whether or not the cone flattens to a plane (triangle), *Fig.* 11, depends entirely upon the shape of the rim line.

Fig. 11—Below—Shell of which one rim line, L, is a straight line. A-B is extended to its point of intersection, S, with the plane of rim line K. Points U and V on rim line K are located by drawing tangent lines from point S to the rim-line curve



Bolted Assemblies

. . . how to determine bolt size and tightening stress for maximum effectiveness



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PROPER design of bolted or threaded fasteners can pose vexatious problems. Initial stresses due to tightening may be difficult to determine or control, and the change in stress in the bolt as a result of the application of external loads to the bolted connection is a function of the elastic properties of the assembly. Fatigue effects resulting from the concentration of stress by the thread grooves may be serious, and other factors such as warpage of assemblies due to uneven tightening must be considered. This article presents the fundamental relationships which underlie the interactions of the parts of a bolted assembly.

STRESSES DUE TO TIGHTENING: Experiments conducted at Sibley College[1] showed that an experienced mechanic tightens a nut so that the initial tension load in a bolt, in pounds, is about 16,000 d, where d is the nominal diameter of the bolt in inches. This result was later confirmed by similar experiments in Germany. One implication of these findings is that bolts of less than ⅝-in. diameter should rarely be used where serious effects would result from the failure of the bolted connection—unless there is specific control of the tightening.

Applying the foregoing relationship to a ¼-in. NF bolt, the initial load, F_i, due to tightening is 4000 lb. The corresponding average tensile stress, S_i, over the root section is therefore $S_i = F_i/A_r = 122{,}800$ psi, A_r, the area at the root section, being 0.0326 sq in., found from thread standard tables.[2] The magnitude of the stress thus determined is beyond the safe range for most bolt materials. Furthermore, the maximum stress at the thread root section will be even higher than the values determined by calculation because of the stress-concentrating nature of the threads.

Fig. 1—Loading and principal dimensions of a threaded fastener consisting of a bolt and a nut

Better control of tightening may be achieved by use of the torque wrench for assembly of bolted connections. The relation between the torque applied to the nut and the axial tension load in a bolt may be determined in terms of the coefficient of friction between the sliding parts and the dimensions of the nut, bolt and threads.

Assuming that pressure is uniformly distributed between the lower face of the nut and the work on which it rests, *Fig.* 1, and that the resultant thread force acts normal to the thread surface at the mean diameter of the threads, it can be shown that

$$T = \frac{F}{2}\left(\frac{p}{\pi} + \frac{Ef}{\cos\alpha} + D_c f_c\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where

T = Torque required to turn the nut, lb-in.
F = Axial tensile load in bolt, lb.
p = Pitch of threads, in.
E = Pitch diameter of screw thread, in.
f = Coefficient of friction between threads
f_c = Coefficient of friction between nut and bolted member
D_c = Mean diameter of nut face or collar, in.

[1]References are tabulated at end of article.

α = One-half the included thread angle measured in a plane through the bolt axis
= 30 deg. for Unified and American screw threads

To solve for the axial load if the torque is known, Equation 1 may be rewritten

$$F = \frac{2T}{\frac{p}{\pi} + \frac{Ef}{\cos \alpha} + D_c f_c} \quad \ldots\ldots (2)$$

Torque on the bolt, T_b, resulting from the friction between the threads is given by

$$T_b = \frac{FEf}{2 \cos \alpha} \quad \ldots\ldots (3)$$

Effect of the helix angle modifies the foregoing equations slightly,[3] but can be neglected for threaded fasteners, where the helix angle is always less than 5 degrees.

Example 1: A ½-20 NF bolt is to be tightened so that the average tensile stress at the thread root section is 30,000 psi; p = 1/20-in. and D_c = 0.667-in. approximately. Determine: (a) torque wrench setting assuming $f = f_c = 0.15$; (b) axial tensile stress developed with the torque wrench setting determined in part (a) if $f = f_c = 0.10$; and (c) average thread root stresses when the torque determined in part (a) is applied to the nut and $f = f_c = 0.15$.

Solution: Root area[2] is A_r = 0.1486, therefore F = 30,000 × 0.1486 = 4460 lb. Also, pitch diameter E = 0.4675.

(a) Substituting in Equation 1, T = 439 lb-in.

(b) Substituting in Equation 2 the values T = 439 and $f = f_c$ = 0.10, it is found that F = 6425 lb, whence $S = F/A_r$ = 43,200 psi average tensile stress, which is 44 per cent greater than when the friction coefficients are 0.15. The results of this calculation indicate the principal uncertainty present in the use of torque wrenches for precision results. The coefficient of friction is subject to considerable variation, being affected by the condition and fit of the thread surface, the lubrication, and the magnitude of the unit pressure between sliding surfaces. Also, the coefficient of running friction is less than the coefficient of starting friction. Thus a nut tightened to the specified torque by a series of small angular movements of the nut may produce a much lower tension in the bolt than that resulting from a continuous angular rotation of the nut until the specified torque is reached.

(c) Substituting in Equation 3 the values F = 4460 lb and f = 0.15, it is found that torque on the bolt is T_b = 180.8 lb-in. Using the well known torsional shearing stress equation $S_s = T_b c/J$ where $c = K/2$ and $J = \pi K^4/32$ (K being the root diameter, which is 0.4387-in. for a ½-20 NF thread) it is found that c = 0.2193, J = 0.00362 and S_s = 11,000 psi. The torque in the bolt produced by thread friction will usually be relieved early in the service life of the bolt either by a slight loosening of the nut or a slippage of the nut or head on the work. Sometimes under pure static loading the torque may never be relieved. The average maximum resultant stresses at the thread root section may be found by the use of the combined stress equations[3], substituting S_t = 30,000 psi and S_s = 11,000 psi:

$$S_{s(max)} = \tfrac{1}{2} \sqrt{S_t^2 + 4S_s^2} = 18{,}500 \text{ psi}$$

$$S_{t(max)} = \tfrac{1}{2} \left[S_t + \sqrt{S_t^2 + 4S_s^2}\right] = 33{,}500 \text{ psi}$$

The maximum stresses at the thread root section may be much higher than these values as a result of the stress-concentrating nature of the thread groove.

Special care must be exercised if consistent results are to be achieved when using the torque wrench. Nut and bolt threads must be in good condition and of such a class of fit that the nut may be screwed up snug by finger pressure alone. The thread should be lubricated, preferably with graphite grease. For threads so lubricated the coefficient of friction will be about 0.10. Some investigators have found that silver plating on either the nut or bolt thread will permit fairly consistent tightening. Where inconsistent or faulty lubrication of the threads occurs it may be that the variation in bolt tension for a given torque will be as much as ten to one.[4] The occurrence of squeal or chatter during the tightening procedure is a good indication of high friction. When this happens undependable results must be expected.

Some bolt-connected matching assemblies may not give satisfactory service unless the initial tension load in the bolts is held to very close limits. For example, uneven tension in engine cylinder head bolts may cause significant warpage if the head is thin, thus

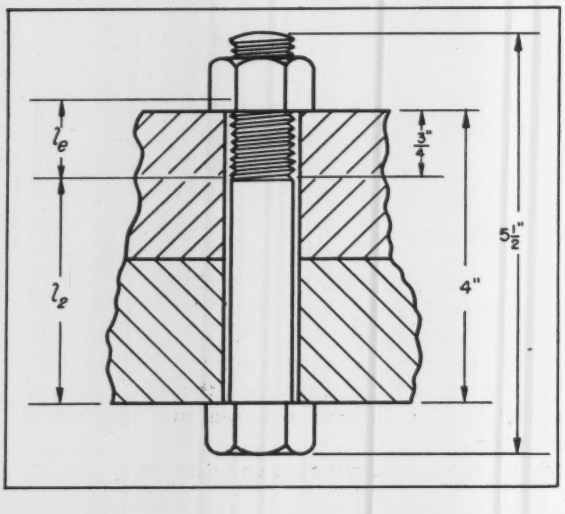


Fig. 2—Left—Bolt dimensions necessary for calculating stretch that should be given the bolt in tightening

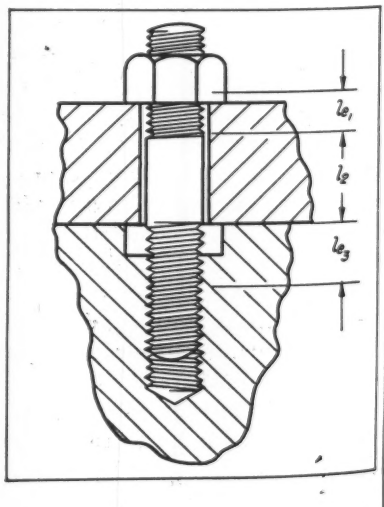


Fig. 3 — Right — Stud-bolt dimensions for calculating the proper nut rotation in tightening to give a predetermined initial loading

permitting leakage under the head as well as unsatisfactory valve service. When close limits on bolt tightening load are required it may not be possible to achieve such limits with torque-wrench tightening under even the best conditions. In such cases the bolt tightening load may be accurately controlled by measuring the stretch of the bolt during tightening. With stud bolts it will not be possible to reach both ends of the stud to measure the tightening stretch. Here consistent tightening may be achieved by giving each nut the same angular rotation from the hand-tight position. Obviously the fit of the nuts and mating parts must be of such accuracy that any further rotation of the stud nut from the hand-tight position will cause a predictable stretch in the stud.

Example 2: A ¾-16 NF steel bolt, *Fig.* 2, is to be tightened so that the direct tension stress in the body of the bolt will be 40,000 psi. What stretch should be given this bolt in tightening?

Solution: For this thread, $A_r = 0.3513$ sq in., bolt body area $A_b = \pi(0.75)^2/4 = 0.442$ sq in., and $p = 1/16 = 0.0625$-in. For a stress of 40,000 psi in the bolt body, the average stress at the thread root section will be approximately $S_{t1} = 0.442 \times 40{,}000/0.3513 = 50{,}300$ psi. It will be assumed that the effective length of threaded section being stretched extends from the third engaged thread in the nut to the end of the threaded section, thus $l_e = 0.75 + (3)(0.0625) = 0.9375$-in. Deformation of the threaded section then is $\epsilon_1 = S_{t1}\, l_e/E = 0.001572$-in. Neglecting the small deformation of the bolt head, the stretch in the unthreaded section due to tightening will be $\epsilon_2 = S_{t2}\, l_2/E = 0.00433$-in. Total stretch $= \epsilon_1 + \epsilon_2 = 0.001572 + 0.00433 = 0.0059$-in., say 0.006-in. If the parts being clamped together by the bolt are very rigid compared to the elasticity of the bolt, the stretch to be given the bolt will be the same as $(\epsilon_1 + \epsilon_2)$. Where the compression deformation of the clamped parts may not be neglected, the stretch of the bolt should be the sum of $(\epsilon_1 + \epsilon_2)$ and the assumed compressive deformation of the clamped parts. In most cases the accurate determination of the deformation of the clamped parts would be very difficult. Usually this uncertainty will not be important since the primary objective in using this procedure of tightening is uniformity in bolt tension, while the absolute magnitude of stresses in bolts is of only secondary importance so long as it may be predicted with fair accuracy.

Example 3: Determine the nut rotation for tightening the ⅝-in. steel stud bolt shown in *Fig.* 3, so that the load in the bolt due to tightening will be 6000 lb. The top thread is NF and the bottom of the stud has NC threads screwed into cast iron. The effective, or stretched, length of thread at the top is measured from the bottom of the threaded section to the third engaged thread in the nut. Since the modulus of elasticity for cast iron is less than that for steel, an approximation of the effective length of the bottom threaded section will be taken as the distance from the beginning of the threaded section to the fifth engaged thread in the cast iron. Dimensions are $l_{e1} = 0.60$-in., $l_2 = 1.25$ in., $l_{e3} = 0.75$-in.

Solution: For the top section, $A_{r1} = 0.2400$-sq in., therefore $S_{t1} = 25{,}000$ psi average, and $\epsilon_1 = S_{t1}\, l_{e1}/E = 0.0005$-in.

For the midsection $A_b = \pi(0.625)^2/4 = 0.307$ sq in., therefore $S_{t2} = 19{,}540$ psi average and $\epsilon_2 = S_{t2}\, l_2/E = 0.000815$-in.

For the bottom section $A_{r3} = 0.2018$ sq in., therefore $S_{t3} = 29{,}750$ psi average and $\epsilon_3 = S_{t3}\, l_{e3}/E = 0.000744$-in.

Total bolt stretch will be $\epsilon_1 + \epsilon_2 + \epsilon_3 = 0.002059$-in., say 0.0021-in. The pitch of the threads at the top is 1/18-in. $= 0.0556$, thus the required nut rotation to produce the required stretch, measured from the hand-tight position is $\theta = (0.0021/0.0556)\ 360 = 13.6$ degrees.

It should be emphasized that for consistent results, when using this tightening procedure, the clamped parts must be clean and accurately fitted and all slack must be taken up by the stud nut before the measured angular rotation of the nut is begun. Reduction of the body diameter of the stud to the root diameter of the lower thread would result in a greater stretch and consequently greater number of degrees of nut rotation for tightening, thus allowing more accurate results since angular error in tightening the nut is independent of the total number of degrees and the percentage error expected would be less. Static strength of the stud would not be reduced by a reduction in the body diameter and, in addition, stress concentration would be less serious.

LOAD AND STRESS DISTRIBUTION IN THREADED CON-

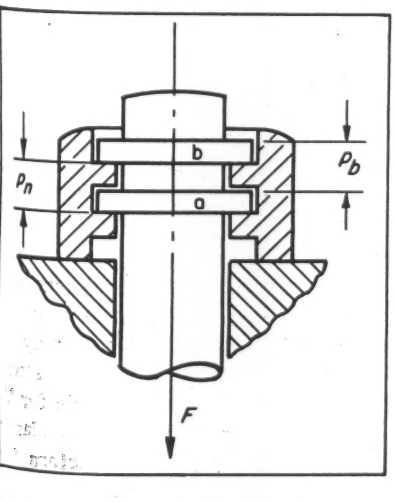
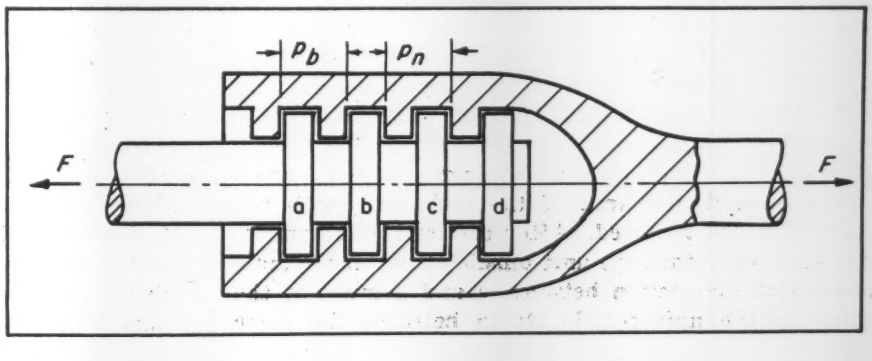


Fig. 4—Left—Idealized nut-bolt connection employing mating rings

Fig. 5—Below—Idealized tension-loaded threaded connection employing a series of mating collars instead of threads



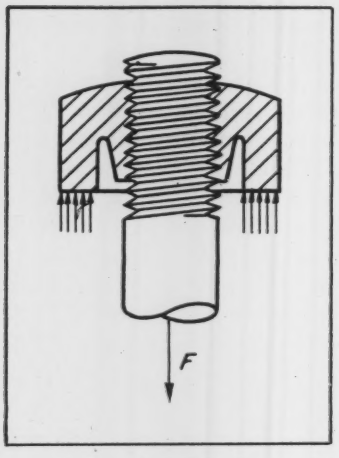


Fig. 6—Left—Nut design employing a stress-relieving groove to improve load distribution on threads

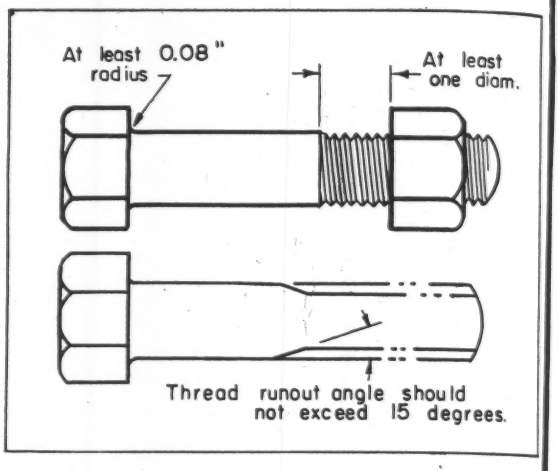


Fig. 7—Right—Bolt design for improved resistance to fatigue failure

NECTIONS: An idealization of a nut-bolt connection is shown in *Fig.* 4. Here the nut and bolt are shown with two mating rings instead of threads. The pitch of the rings on the bolt is p_b and the pitch in the nut is p_n, the two being assumed equal before the load is applied to the bolt. The nut and bolt are assumed to behave elastically under load. The question is, what proportion of the load in the bolt is transmitted to the nut by ring *a*. The answer, surprisingly enough, is that all the load is carried by ring *a* and no load is taken by ring *b*. This conclusion may be reached by assuming that *b* takes some load. If such were the case, the section of the bolt between *a* and *b* would be under a tension stress and the section of the nut between *a* and *b* would be subjected to a compression stress. These stresses would result in a decrease in p_n and an increase in p_b. These neccessary deformations would cause a separation of the rings at *b*! Thus the conclusion must be that no load is transmitted by *b*.

The analysis just given may be applied, with some modification, to the load distribution between the threads of an actual bolt and nut. The fact that the actual bolt has a continuous helical groove instead of rings will make some difference.

For an actual nut and bolt with helical V-threads it could logically be concluded that as long as the deformation is elastic the first one or two threads carry the major portion of the load. Photoelastic studies verify this conclusion. As the load in the bolt increases, plastic deformation due to yielding will occur in the first engaged threads, permitting adjacent engaged threads to carry a portion of the load.

An idealization of a tension-loaded threaded connection is shown in *Fig.* 5. The connection has four mating rings on the male and female parts. The pitch of the rings on the male part is p_b and the pitch of the rings in the female part is p_n. These pitches are assumed to be the same before load application. It will be further assumed that the load-carrying areas in male and female parts of the joint are the same, that is, the cross-sectional area of the female part of the connection with rings omitted equals the cross sectional area of the male part with the rings assumed removed. After the load *F* is applied, it may be seen that the unit tensile strain in the male part of the connction between *a* and *d* must be the same as the unit tensile strain between the same two points for the female part. If the unit tensile strain in the female part were greater than that for the male part, no contact could occur at rings *a*, *b* and *c* assuming contact between the rings at *d*. But with no contact of rings *a*, *b* or *c* there can be no load in the female part of the connection to the left of *d*! If the unit tensile strain in the female part be less than the unit tensile strain in the male part between sections *a* and *d*, interference of the rings would result. Therefore, it must be concluded that the unit tensile strains are equal in the sections between *a* and *d*. If there is no change in the unit tensile strain of either part of the connection between sections *a* and *d* it must also be concluded that no load is transmitted by rings *b* or *c*. Half the load would be transmitted by the rings at *d* and the other half by the rings at *a*. The rings at *b* and *c* will remain in contract but will transmit no load.

An actual tension connection has helical threads instead of rings and the effective cross-sectional area of the female part of the connection is larger than that of the male part. Here the major portion of the load will be transmitted between the parts by the engaged threads near the end of the female part. There will not be as excessive a loading on the first engaged threads as for a bolted connection with the nut in compression.

Threaded connections which place both the nut and bolt in tension have a more uniform loading of the engaged threads than those which have the nut in compression and the bolt in tension. For some applications nuts are made with a groove so that the lower threaded part of the nut will be in tension. Load distribution on the threads is improved and the stress at thread roots is lower for this type of nut than for the conventional type. An example of a nut with stress-relieving groove is shown in *Fig.* 6.

STRESS CONCENTRATION AND FATIGUE OF THREADS: The stress determined by dividing the load in the bolt by the root area of the thread is the average value of the stress at that section. Two-dimensional photoelastic studies indicate that the stress at the thread root of the second engaged thread may be 10 times as large as the average maximum stress at the root section[5]. These studies were made for V-threads with sharp roots. The results of photoelastic analysis show the stress concentration factors for

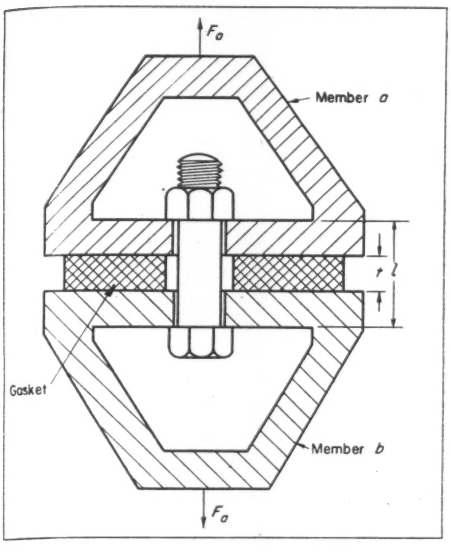


Fig. 8—Left—Bolted joint employing a relatively elastic gasket between the members

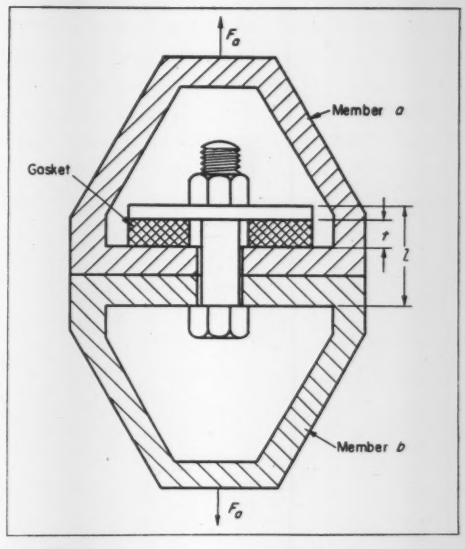


Fig. 9—Right—Bolted joint employing an elastic gasket under the nut, which adds to the elasticity of the bolt assembly

Whitworth, U. S. Standard and Sellers square threads to be 3.86, 5.62 and 11.12, respectively[6]. The stress concentration for threads as determined by actual test are somewhat lower than those indicated by photoelastic study and in addition, the factors are a function of the bolt material.

Tests by Moore and Henwood[7] give the following stress concentration factors for Whitworth and U. S. Standard bolts:

Material	Stress Concentration Factor	
	Whitworth	U. S. Standard
Medium carbon steel	1.76	2.84
SAE 2320, heat treated	3.32	3.85

At first thought it might seem that the heat-treated bolts would be weaker because of the higher stress concentration factor. This is not necessarily so because the greater strength of the heat-treated SAE 2320 may more than offset the increase in the stress concentration factor. It is probable that the stress concentration factor for the new Unified Standard threads, which have rounded root contours, will be comparable to those found for the British Whitworth type.

W. Staedel[8] has suggested that the likelihood of fatigue failure may be reduced in many cases by extending the threads at least one bolt diameter below the nut and tapering the thread runout as indicated in *Fig.* 7. Fatigue cracks at the junction of bolt and head may be prevented by providing a radius at this point.

A reduction of the shank or body diameter of a bolt to a value equal to or slightly less than the root diameter of the thread increases the capacity of the bolt to absorb strain energy. This results from the higher stress which may be developed in the bolt body for any given maximum stress to which the threaded area may be subjected. An incidental advantage accruing from a reduction in shank diameter is the greater total stretch in the bolt during tightening. Thus a small loosening rotation of the nut or slight wear under the head or nut will not result in as great a percentage decrease in the tightening load of the bolt as would be the case for a bolt with full body diameter. A bolt with reduced shank diameter is as strong as a regular bolt when subjected to a static load and much stronger when subjected to impact loads. If any incidental bending of the bolt occurs, a reduced shank bolt will develop smaller bending stresses than a bolt of full diameter shank.

EFFECT OF APPLIED LOADS ON BOLT STRESSES: The bolted joint of *Fig.* 8 is typical of bolted connections which use a gasket. In the analysis of this assembly it is assumed that members a and b are rigid and that the bolt and gasket have elastic behavior, that is, that deformation of the bolt or gasket is directly proportional to the load to which it is subjected.

Before application of the applied load, F_a, the tensile load F_i in the bolt equals the compression load on the gasket. After the application of load F_a, the bolt and gasket will increase in length by the amount Δ inches. The increase in bolt load due to the change in length will be $\Delta E_b A_b/l$ and the decrease in gasket load will be $\Delta E_g A_g/t$, where E_b and E_g are the elastic moduli of the bolt and gasket materials, psi; A_b is the cross-sectional area of the bolt, sq in.; A_g is the loaded area of the gasket, sq in.; t is the thickness of the gasket, in.; and l is the effective length of the bolt, in.

Applying the equation of static equilibrium for member a, $\Sigma F = 0$ or

$$F_a + \left(F_i - \frac{\Delta E_g A_g}{t}\right) - \left(F_i + \frac{\Delta E_b A_b}{l}\right) = 0$$

From which

$$\Delta = \frac{F_a}{\frac{E_b A_b}{l} + \frac{E_g A_g}{t}}$$

Final load on the bolt is

$$F = \frac{\Delta E_b A_b}{l} + F_i = F_a \left\{ \frac{\frac{E_b A_b}{l}}{\frac{E_b A_b}{l} + \frac{E_g A_g}{t}} \right\} + F_i$$

$$F = KF_a + F_i \qquad (4)$$

Quantity K may have values between zero and one. If the gasket is hard and thin and of large area, the term $E_g A_g/t$ will be large compared to $E_b A_b/l$,

thus K will approach zero. For gaskets that are soft the term $E_g A_g/t$ may become so small compared to $E_b A_b/l$ that the value of K approaches one. If no gasket is used between the members the value of K is zero. The absence of a gasket between the members is the same as having a gasket of infinite stiffness, that is, $E_g A_g/t = \infty$. It should be noted that Equation 4 is valid only as long as the gasket remains in contact with the bolt-connected members. If the bolt should be stretched beyond this point, $F = F_a$.

Equation 4 has great significance for the design engineer because it indicates how the danger of fatigue failure of bolts may be minimized. Even though the load applied to a bolted joint may be highly variable in nature and of an impact type, the load variation in the bolt itself may be very small if a stiff gasket is used. With metal-to-metal contact between both connected parts, K is essentially zero and no fatigue failure can occur in the bolt since the bolt load is essentially constant regardless of the nature of F_a, providing F_a is less than F_i.

Computation of the value of K may be fairly difficult for bolt-connected parts if the gasket is of rubber or a similar material. Even though the rubber gasket is elastic it will flow under high pressure and act somewhat as an incompressible fluid. At high unit pressures the effective modulus of elasticity for a rubber gasket is much higher than that found for low pressures. At present little information has been published as to the elastic behavior of gasket materials. Tests made by the author show that in normal applications K seldom exceeds 0.50 for even the softest and most flexible gasket materials.

It should be noted that if the gasket is deteriorated by service conditions such as heat or corrosion, the initial tension in the bolt may be lost, thus subjecting the bolt to the full variation of the applied load. Early fatigue failure of the bolt may be suspected in this event.

If a gasket or spring washer is placed underneath the nut as shown in *Fig.* 9 the effect on the bolt is not the same as when the gasket is between the bolt connected members. The reaction of member b on member a is F_{ba}. Since there is metal-to-metal contact between the members it must be concluded that any stretch of the bolt due to the application of F_a would permit separation of the members, thus making $F_{ba} = 0$. This is not possible as long as F_i is greater than F_a. A gasket or spring washer under the nut or head of a bolt has no effect on bolt load variation. As mentioned before, any deterioration of the gasket under the nut or head will allow the initial tightening load to be lost, thus subjecting the bolt to the full variation of the applied load.

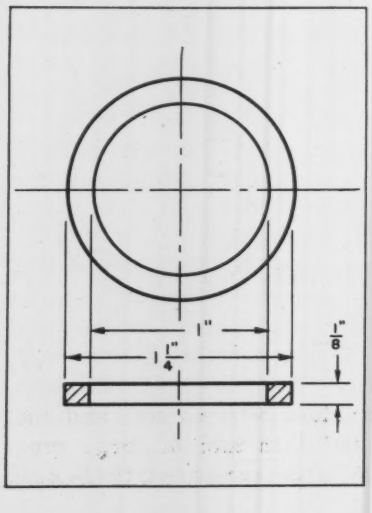


Fig. 10—Dimensions of aluminum alloy gasket ring for use in a joint of the design shown in Fig. 8

Metal Ring Gasket Design

Example 4: A bolted connection like that of *Fig.* 8 has a gasket that is an aluminum alloy ring of the dimensions shown in *Fig.* 10: $A_b = 0.1964$ sq in., $E_b = 30(10)^6$ psi, l (effective) $= 4$ in., $F_i = 4000$ lb, and $F_a = 3000$ lb. Determine: (a) the value of the factor K; (b) the final load in the bolt; (c) the probable maximum stress at the thread root assuming threads are U. S. Standard form with root area 0.1486 sq in.; and (d) the probable maximum stress at the thread root for $F_i = 6000$ lb and $F_a = 3000$ lb.

Solution: (a) Area $A_g = \pi(1.25^2 - 1.00^2)/4 = 0.442$ sq in., and $E_g = 10(10)^6$ psi, therefore, from Equation 4, $K = 0.04$. The stiffness of this gasket is so great that the deflection of the bolt-connected parts would have some effect on the value of K. Normally, however, the percentage error is probably fairly small.

(b) Final load in the bolt, from Equation 4, is $F = 0.04 \times 3000 + 4000 = 4120$ lb.

(c) It will be assumed that any direct shear stress in the bolt resulting from the tightening has been relieved by slippage of the nut or bolt head. This slippage will occur usually at the first variation of load in the bolt. The average tension stress at the thread root area is $S_t = 4120/0.1486 = 27{,}800$ psi. The peak stress occurring at the thread root is the product of the average stress and the stress concentration factor. $S_{t(max)} = 27{,}800 \times 3.85 = 107{,}000$ psi. The yield stress in tension for SAE 2320 quenched and drawn at 800 F is 110,000 psi.

(d) From Equation 4 the final load is $F = 0.04 \times 3000 + 6000 = 6120$ lb, whence $S_t = 6120/0.1486 = 41{,}200$ psi, average, and $S_{t(max)} = 41{,}200 \times 3.85 = 158{,}700$ psi. The maximum stress indicated here is above the yield strength of the material and is even greater than the ultimate strength in tension, which is 140,000 psi. The stress concentration factor used was determined from conditions where elastic behavior was present and does not apply where yielding and plastic flow occurs. The probable maximum stress at the thread root is a value slightly greater than the yield strength of the material. It should be noted that the bolt would be especially sensitive to a fatigue failure at the thread root if the load variation in the bolt is appreciable. A load variation of only 120 lb would probably not cause difficulty.

Example 5: The cross section of the cover plate for an opening to a surge chamber is shown in *Fig.* 11. Pressure in the chamber varies from 300 psi to 1500 psi 60 times each minute. A preliminary design is to be made using a 1-in. wide, 1/8-in. thick, rubberized fabric gasket for which the manufacturer advises an initial unit contact pressure for effective sealing under these conditions of 3000 psi. For lack

of exact information as to gasket elasticity it will be assumed that the factor K will be approximately 0.50. Design a suitable bolted connection for this service.

Solution: It will be assumed that effective sealing of the internal pressure occurs at the middle of the gasket. Area of cover plate subjected to pressure will be $\pi(9)^2/4 = 63.7$ sq in., and the maximum pressure on the cover will be $F_a = 63.7 \times 1500 = 95{,}500$ lb. Initial tightening load required is the applied load plus load due to 3000 psi on outer half of gasket $= F_i = 95{,}500 + \pi(9.5)(0.5)(3000) = 140{,}200$ lb. From Equation 4 the maximum load on the bolts will be $F = 0.50 \times 95{,}500 + 140{,}200 = 187{,}950$ lb. Average internal force on the cover is $63.7(1500 + 300)/2 = 57{,}330$ lb, therefore, the mean load on the bolts is $F_m = 0.50 \times 57{,}330 + 140{,}200 = 168{,}860$ lb. The load variation from the mean load is $187{,}950 - 168{,}860 = 19{,}090$ lb.

It will be assumed that the bolts for this joint are to be SAE 2320 steel quenched and drawn at 800 F, for which the yield strength in tension is 110,000 psi and the endurance limit in completely reversed bending is 68,000 psi. Because the number of load variations on the bolts will be very large it will be necessary to consider fatigue effects in the design of the bolts.

How to find the endurance limit for such conditions as this is illustrated in most standard texts on machine design[3]. As shown in *Fig.* 12, a plot is made with point S on the x-axis representing the yield strength in tension to scale and point V on the y-axis representing the endurance limit. From O, a line is drawn with a slope equal to the ratio of the variable stress to the mean stress. Here neither the mean stress nor the variable stress is known. However, the ratio of the stresses will be the same as the ratio of the loads, hence $S_{var}/S_{mean} = F_v/F_m = 19{,}090/168{,}860 = 0.113$.

From O a line is drawn with a slope of 0.113. The line connecting V and S crosses this line at D. From D horizontal and vertical lines are drawn intersecting the axes. OC represents the permissible mean stress to scale and OE represents the permissible variable stress to scale. These values are $S_m = 92{,}700$ psi and $S_v = 10{,}600$ psi. The endurance limit is the sum of S_m and S_v, or $S_e = 103{,}300$ psi.

Assuming a real factor of safety of 1.75 and a stress concentration factor for the threads of 3.85, the permissible average stress at the thread root section will be $S_{av} = 103{,}300/(1.75 \times 3.85) = 15{,}340$ psi. The required root area for all the bolts is $187{,}950/15{,}340 = 12.25$ sq in. Assuming that 12 bolts are to be used, the required root area per bolt is $A_r = 12.25/12 = 1.02$. The smallest NF bolt having the required root area is $1\frac{1}{4}$ in. diameter.

The problem just worked out is rather an extreme case and the solution obtained is not very practicable. A bolted cover having twelve $1\frac{1}{4}$-in. diameter bolts would be exceedingly bulky. The difficulty here lies in the choice of gasket. In the following example an alternative design will be made using a metal ring gasket.

Example 6: The cover plate bolts for the conditions of *Example* 5 will be designed to use a soft copper ring as a gasket, as shown in *Fig.* 13. It will be as-

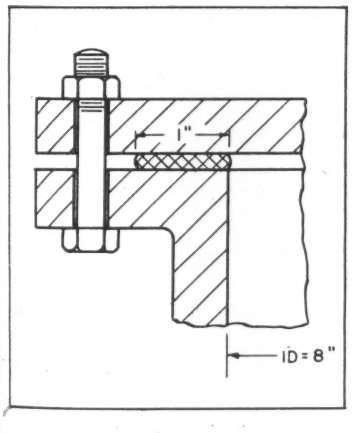


Fig. 11—Left — Cover plate design employing a rubberized fabric gasket which is relatively elastic

Fig. 12 — Below — Graphical solution for permissible mean and variable stresses in bolts shown in Fig. 11

Fig. 13—Right—Cover plate design alternative to Fig. 11, employing a soft copper ring gasket which is relatively stiff

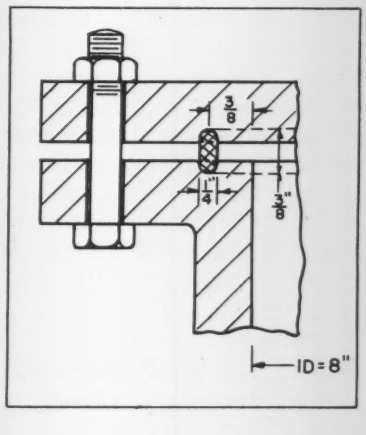
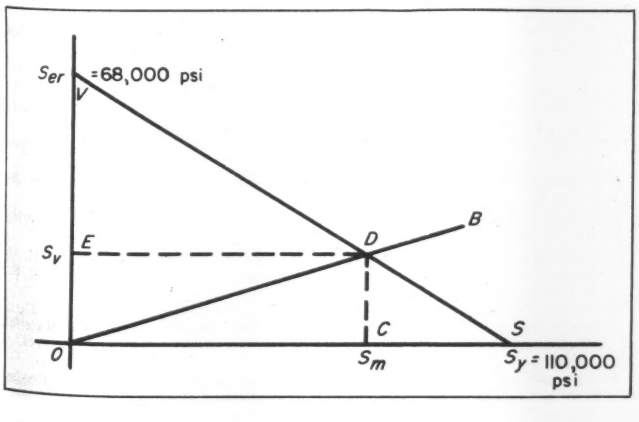
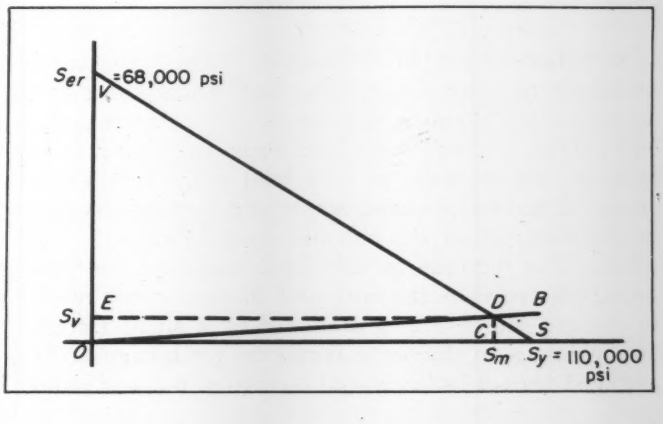


Fig. 14 — Below — Graphical solution for permissible mean and variable stresses in bolts shown in Fig. 13





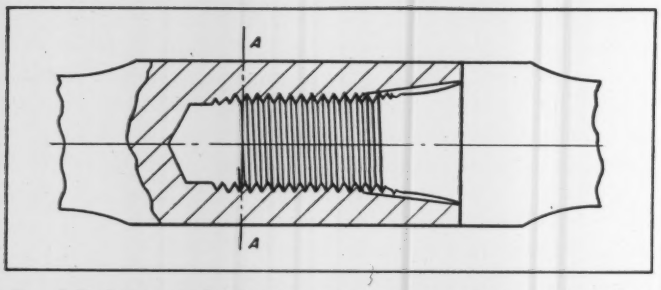


Fig. 15—Design of joint for sucker rod which is assembled with high tightening load for push-pull application

sumed that effective sealing may be achieved with this gasket by initial tightening of the bolts such that the compression load on the gasket is 130 per cent of the maximum applied load from the internal pressure.

Solution: Assuming the seal to be effected at the center of the gasket, the pressure area $= \pi(8.75)^2/4 = 60.1$ sq in., and the initial load in the bolts is $F_i = 1.3 \times 60.1 \times 1500 = 117{,}100$ lb. Magnitude of the factor K cannot be determined at this point since the size and number of the bolts is as yet undetermined. A conservative assumption will be made as to the value of this quantity, say $K = 0.07$. The load applied to the cover is $F_a = 60.1 \times 1500 = 90{,}100$ lb and the maximum load on the bolts, from Equation 4, is $F = 0.07 \times 90{,}100 + 117{,}100 = 123{,}400$ lb. Average internal force on the cover is $60.1(1500 + 300)/2 = 54{,}100$ lb, hence the mean load on the bolts is $F_m = 117{,}100 + 0.07 \times 54{,}100 = 120{,}900$ lb. The load variation from the mean load is $123{,}400 - 120{,}900 = 2500$ lb.

The endurance limit under this combination of loadings is determined by drawing an endurance diagram as in *Example* 5. Here, $S_{var}/S_{mean} = 2500/120{,}900 = 0.0207$ and from the diagram, *Fig.* 14, $S_m = 106{,}300$ psi, $S_v = 2200$ psi, and $S_e = S_m + S_v = 108\,500$ psi.

Assuming a real factor of safety of 1.75 and a stress concentration factor of 3.85, the permissible average stress at the thread root section will be $S_{av} = 108{,}500/(1.75 \times 3.85) = 16{,}100$ psi. The required root area for all the bolts is therefore $123{,}400/16{,}100 = 7.67$ sq in. Assuming that 12 bolts are to be used, the required root area per bolt is $A_r = 7.67/12 = 0.638$ sq in.

The smallest NF bolt having the required root area is 1-in. diameter for which $A_r = 0.6464$ sq in. In view of the small bolt load variation, it is probable that a ⅞-in. NF bolt could be used for which $A_r = 0.4805$ sq in.

NUT LOOSENING BY VIBRATION: The progressive loosening of nuts by variable bolt loading has been discussed by Goodier and Sweeney[9]. The nut of a bolt carries a compressive load while the bolt is under tension. An increase in bolt load will cause an increase in the longitudinal strain and a slight decrease in the diameter of the bolt due to the Poisson's ratio effect. The increase in bolt load increases the compressive stress in the nut and consequently results in the nut increasing in diameter by a small amount. The changes in diameter result in a slippage of the engaged thread in the radial direction, but not purely radial because of the circumferential component of the normal thread pressure. The relative slippage of the threads will be such as to follow the path of least resistance. Net effect of load variation is such as to cause the nut to loosen a small amount during each load cycle. Goodier and Sweeney describe the mechanism of this loosening as a "frictional ratchet." It would seem on the basis of this argument that a cast iron or brass nut on a steel bolt would have a greater tendency to loosen under vibration service than would a steel nut. Nuts of brass or cast iron are sometimes recommended for service where bolt load is variable because there is a more uniform transfer of load on the mating threads as a result of the lesser modulus of elasticity of cast iron and bronze. Care must be exercised to prevent loosening of nuts in service where the variation of applied load to the connection and a relatively soft gasket result in large variations of bolt load.

Short bolts and studs should be avoided if possible where variable load conditions are to be met. If their use cannot be avoided they should be made with reduced shank diameter in order that the amount of stretch in tightening is as large as practicable. Referring to *Example* 3, it may be seen that a serious reduction in the initial bolt load will occur with only a few degrees of loosening of the nut. Even if the nut were secured with safety wire a significant amount of nut loosening might occur.

THREADED CONNECTORS FOR PUSH-PULL RODS: Machine parts such as push-pull rods, sucker rods and drill pipe for oil field service require threaded connectors of a special type. If a simple threaded connection such as a pipe thread and coupling were used the variable loads imposed would initiate early fatigue failure at the first engaged thread.

A sucker rod joint is shown in *Fig.* 15. This joint is assembled using a high torque thereby developing a high tightening load F_i in the threaded section. The reaction between the mating shoulders will then be equal to F_i. As long as the varying applied load F_a does not exceed F_i there can be no separation of the mating shoulders and consequently no change in the stress or strain of the male part of the joint. The threaded part of the female member at section *A-A* is subjected to the full load variation but fatigue failure can be prevented here by making the cross-sectional area large enough to reduce the thread root stress to a safe value.

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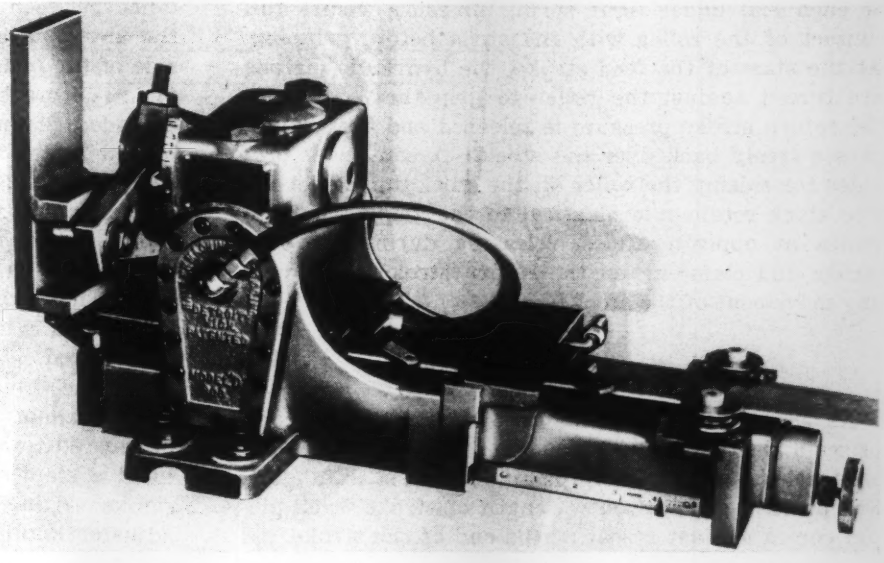


Fig. 1—Haller hydraulic stock feed, showing ram-actuated driving bracket at left with stock being fed from right

Hydraulic Press Feed

. . . Is Ram Actuated

ACCURACY of punch press stock feed within 0.003 to 0.005-in. is obtained with the hydraulically operated unit illustrated in *Fig.* 1. Duplicating length of stroke and clamping of stock during the return stroke of the feed mechanism, the equipment utilizes a stock gripper, a mechanism which moves the gripper to feed the stock and a stationary stock retainer which holds the stock from moving except during the feed stroke.

All mechanisms are powered by oil from a built-in pump, *Fig.* 2, which has a double-ended piston driven from a bracket on the press ram. On the up stroke of the ram, the front piston delivers oil to operate the gripper and feed the stock. On the down stroke, the rear piston delivers oil to operate the stock retainer and return the feeding mechanism to starting position. By-pass valves, preventing excessive pressure in the system, discharge into the reservoir at the top of the pump.

The gripper assembly, *Fig.* 3, includes four hydraulic pistons and a floating roller which contacts the full width of the stock. Plungers

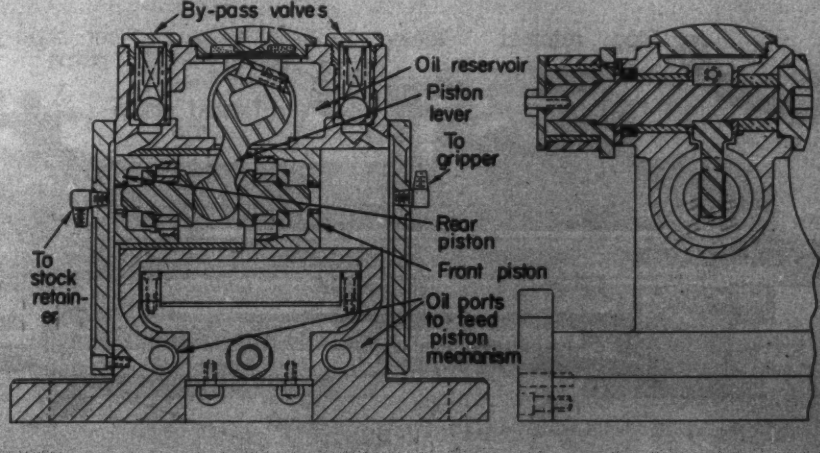


Fig. 2—Sections through hydraulic pump driven by operating arm seen at left in Fig. 1

at each end under light spring pressure assure full contact of the roller with the stock before gripping. At the start of the feed stroke, the hydraulic pistons are forced against the roller to grip the stock. On the return stroke pressure is released and the gripper passes freely back over the stock. A cam lever provides for raising the roller off the stock during set-up. The stock retainer is identical to the gripper but operates at opposite times, releasing during the feed stroke and clamping on the return stroke to prevent any movement of the stock.

Adjusting Feed Mechanism

As shown in *Fig.* 4, the feeding mechanism comprises a sleeve with an extension to which the gripper is attached and two slave pistons mounted in tandem. For positive duplication of length of stroke, each piston comes against a seat at the end of the stroke. A dashpot arrangement prevents heavy impact while permitting positive contact.

Length of feed is adjusted by changing the distance between the slave pistons, as follows: Inside the sleeve, *Fig.* 4, is a threaded piston rod and inside of the piston rod is a square rod. The front slave piston is brazed to the sleeve and threaded onto the threaded piston rod, while the rear slave piston is brazed to the end of the threaded piston rod. Thus the pistons are fastened together by the threaded rod, the piston assembly reciprocating along the rod.

The square rod fits a square hole in the rear slave piston, and is fastened to a gear at the right-hand end. Thus, when the stroke adjuster knob is turned, the motion is transferred through the two gears to the square rod. This turns the rear slave piston, and hence the threaded piston rod. Since the front slave piston cannot rotate, it is moved along the threaded piston rod toward or away from the rear slave piston to give stepless adjustment of length of stroke. The stroke setting is shown by a pointer on the stroke adjuster knob shaft. Designed by Haller Machine & Mfg. Co. Inc., Detroit, the unit takes all stock to 4-inch width and 3/32-inch thickness, and feeds any desired length to 5 inches.

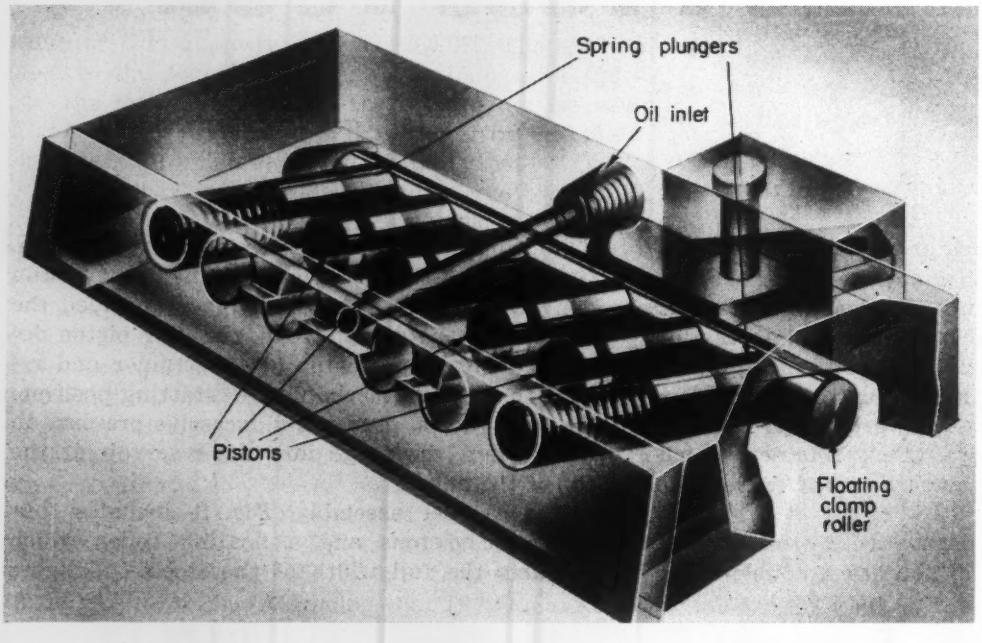
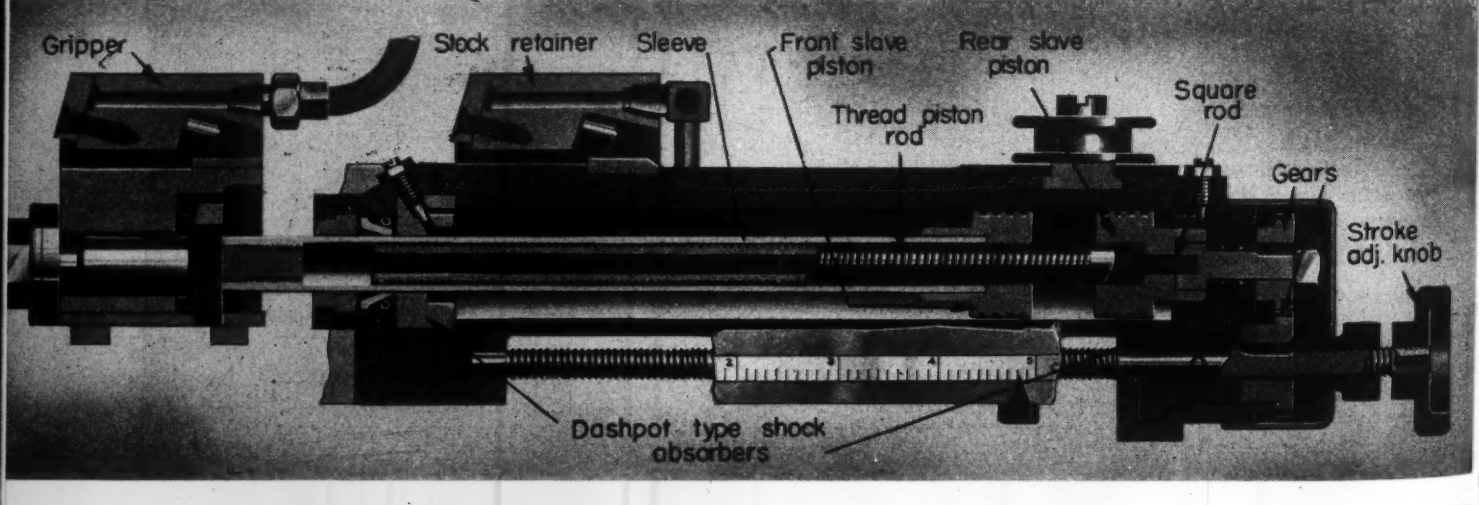
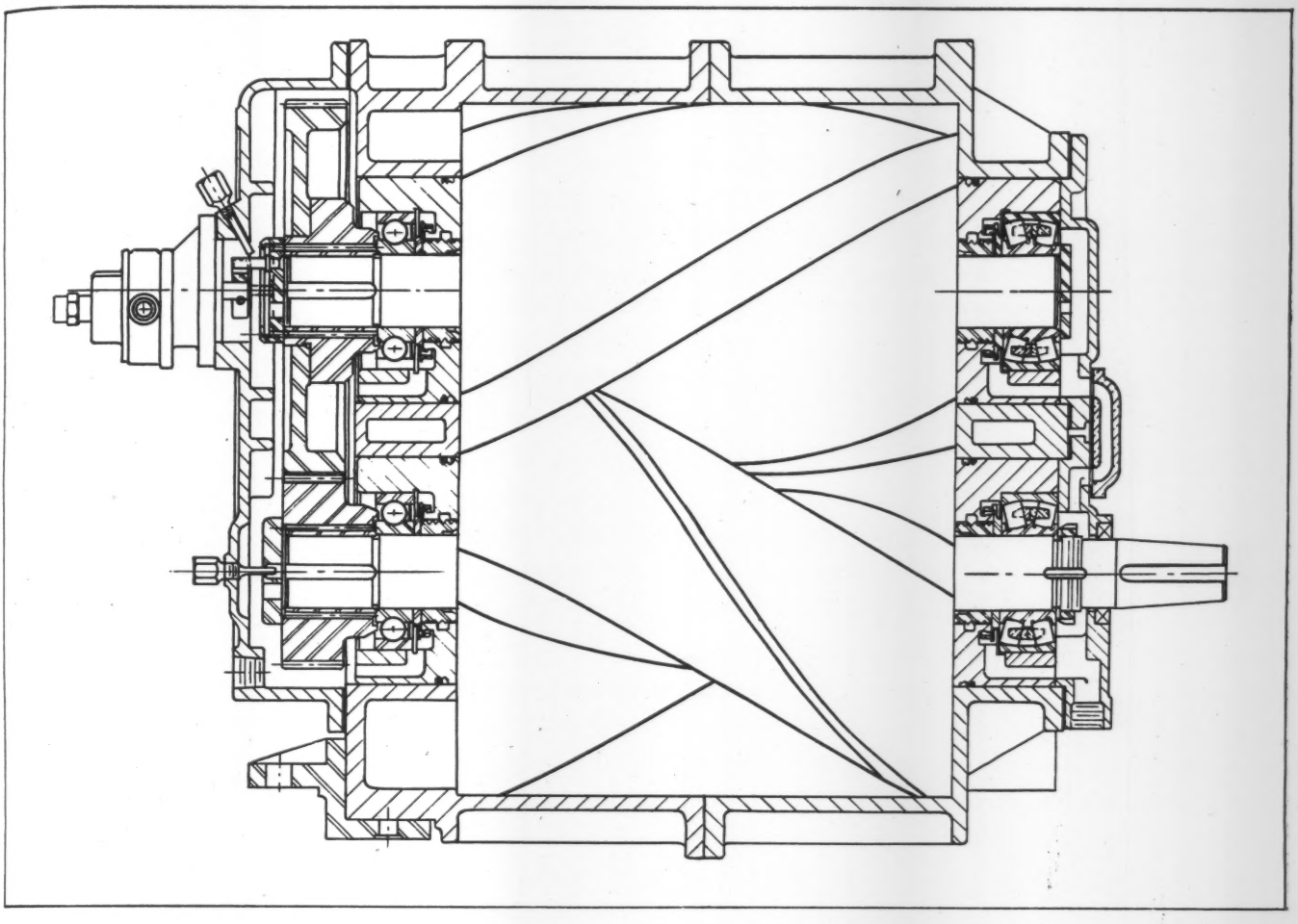


Fig. 3—Left—Phantom view of hydraulic gripper assembly showing floating roller, pistons and spring plungers

Fig. 4 — Below — Section through feed operating mechanism used to adjust length of stock feed stroke





Helical Gated Rotors

. . . improve performance of axial-flow blower

By Fred D. Mosher
Assistant to Vice President
The Standard Stoker Company Inc.
Erie, Pa.

FOR many years engineers have recognized the need for an improved type of positive-displacement blower. In this field, design has been based on an evolving art rather than on a rational process.

Industry has, until more recent times, been thoroughly acclimated to the use of blowers of the "cross-flow" type in which compression of the fluid is intermittent. The compression shocks involved have dictated low rotor speeds, rugged construction and a consequent high ratio of weight to output. Noise becomes a serious problem in blowers using the cross-flow principle as the speed of the machine is increased. Consequently the cross-flow blower is a slow-speed machine.

Rapid expansion in the two-cycle diesel engine field has emphasized the need for a lightweight high-speed positive-displacement blower for scavenging purposes. Other applications for such blowers are those which can use direct drives, eliminating the need for speed

Fig. 1—Above—Cross-sectional view of Standardaire blower

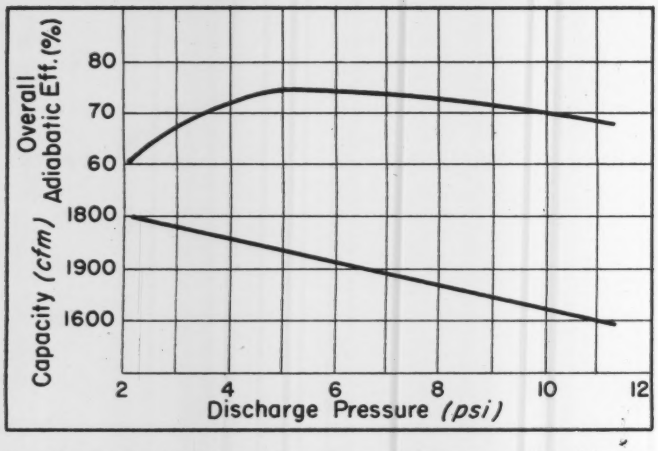


Fig. 2—Typical test results of a medium capacity blower operating at 1750 rpm

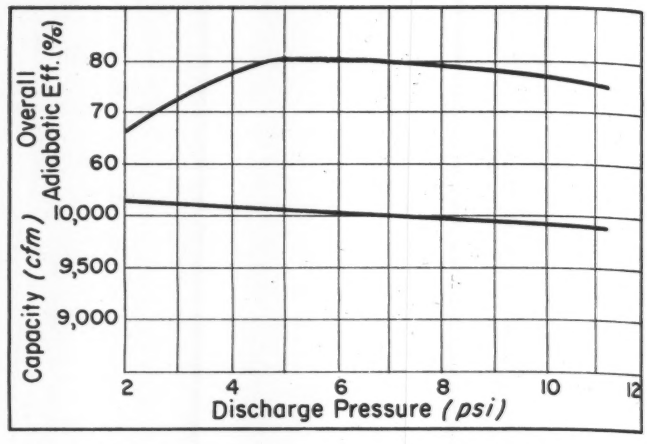


Fig. 3—Typical test results of large capacity blower operating at efficient pressure speed ratios

reduction between the drive and the blower. For the most part engine scavenging has been accomplished through the use of modifications of the cross-flow type blower and the use of lightweight materials to reduce the high weight-to-output ratio as much as possible.

Usual attempts to circumvent the various disadvantages of the cross-flow type blower have centered around the axial-flow principle, incorporation of which in positive-displacement type blowers introduces a number of problems. Possibility of high leakage dictates special considerations in rotor design which, in turn, raise manufacturing problems. The close rotor clearances that must be maintained add to the cost of the blower because of special provisions for maintaining alignment; axial thrust must be absorbed in such a way that no losses in efficiency result.

A successful development of an axial-flow positive pressure blower is embodied in the design shown in *Fig.* 1. The fundamentals of this machine were well understood prior to World War II, and its production during the war years was devoted entirely to the war effort. A standardized unit was built during this period.*

In 1948, the Standard Stoker Company Inc. undertook the further development of the blower for general industrial application.

2000-CFM Blower Tested

A test blower with a maximum capacity of 2000 cfm was built. The blower casting and rotors were made of close-grained cast iron, the rotors being carried on heat-treated steel shafts specially designed for rigidity. Semi-hard shaved gears were used to keep the rotors in proper timed relation and prevent their contact. Pressure lubrication and anti-friction bearings were employed throughout. Oil was prevented from entering the air stream by nonwearing labyrinth type oil seals, to insure delivery of absolutely clear air.

Results of standard ASME tests showed that in every respect, performance was up to expectations. As shown in *Fig.* 2, an overall adiabatic efficiency of 75 per cent was obtained. Tests on the first blower indicated about one cubic foot per minute per revolution. Due to the short leakage path the "slip rpm" was low. This particular feature of the blower enhances the efficiency as sizes are increased, and, consequently, overall efficiency of the larger blowers is higher than the medium units. This higher efficiency is shown in *Fig.* 3 which gives the characteristics of a large capacity blower. Units smaller than the medium size—100 to 1000 cfm—will show the lowest overall efficiency. This is to be expected. For applications where the smaller units are used the overall efficiency, in most instances, is not an important factor in determining selection.

Details of the rotor forms are shown in *Figs.* 1 and 4. The two-lobe rotor, called the main rotor, turns at twice the speed of the four-lobe rotor, or gate. The rotor speed ratio of two to one gives the maximum capacity for a given size unit. This speed ratio also minimizes torsional vibration at high speeds, which is important particularly when the blower is direct connected to a prime mover such as an internal combustion engine.

The helical threads of the main rotor extend through 180 degrees from one end to the other in a right-hand helix. The four helical threads of the gate rotor run in a left-hand helix extending through 90 degrees from one end to the other. The thread forms, which are generated, are symmetrical.

In rotor selection for axial-flow positive-displacement blowers, the designer has an apparent "freedom of action" with respect to speed ratios and the number of lobes per rotor. The wide choice is only a theoretical possibility. To exaggerate, a rotor combination could be selected that would give a large number of lobes to the extent that the rotors themselves would be in the nature of gears and consequently would have no "pockets" in which the air could be compressed. At the other extreme, a two-lobe gate rotor running with a two-lobe main rotor would have a high cubic feet per revolution output but sealing against backflow or slip would become a serious consideration. While such a machine would have a high cubic feet per revolution output, it would be accompanied by high slip and there would be no net gain. The designer

* J. E. Whitfield—"Blower Design Utilizes Screw Principle," MACHINE DESIGN, April, 1943, Page 147.

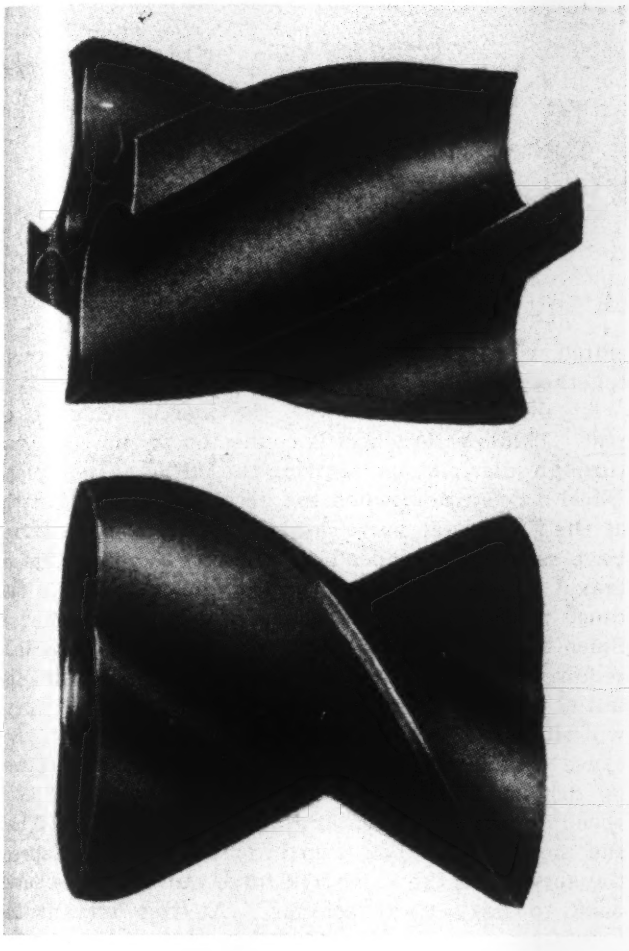


Fig. 4—Two-lobe main rotor and four-lobe gate rotor, showing helical threads

is always faced with such a compromise, or a series of compromises, in which the best combination is selected to give output, efficiency and low weight.

If a third lobe is added to the main rotor better sealing may be expected, but more metal is added and the pockets become smaller and output for a given size machine is reduced. In going to higher than usual pressures, however, a three-lobe main rotor may be necessary. The number of lobes does not materially affect balancing or torsional vibration in axial-flow blowers of moderate speeds.

Practically all the work in the blower is performed by the main rotor, the gate rotor acting only as a valve. Grooves in the gate rotor are equal on each side, and these grooves, being exposed to the compression pressure load, are equalized so that practically no load is carried by the timing gears. It has been found desirable, however, to load the gears about ten per cent to prevent chatter.

An age-old problem with blowers has been contamination of the fluid with lubricating oil. The problem of oil leakage has been aggravated by the fact that the suction end of the blower is under a slight vacuum; in many instances this vacuum may be high. In the Standardaire design a narrow groove in a bronze sealing member around the shaft breaks any vacuum before it reaches the bearings and gears.

The problem of clearances is always confronting the blower designer, and materials must be selected with care. Clearances between rotors and between rotor and casing are held, as far as practicable, from 0.008 to 0.010 in. to give minimum slip and maximum overall efficiency. Lower tolerances are desirable, but the tolerances used in practice are dictated by manufacturing procedures.

In this type of blower, bearing and shaft design must be such that the fine clearances obtained in final assembly must be maintained in actual practice; this dictates a construction in which end play and transverse whip are negligible.

Table 1—Typical Weights and Capacities

(Outlet pressures 2 to 10 psi)

Weight (Lb)	Speed (rpm)	Capacities (cfm)
200	1800	100
600	2800	900
1200	1800	2475
2100	1800	4550
3200	1500	7350
4200	1200	10400

Weight is an important consideration in a large number of applications, and aluminum lends itself quite well to casing construction. Aluminum is quite satisfactory for blower rotors where large clearances can be tolerated. However, the clearances in the axial-flow blower are so close that aluminum rotors are likely to seize under certain load conditions. High-grade aluminum bronze has good expansion characteristics for rotor construction, and this material, in combination with aluminum casings, makes a satisfactory lightweight blower.

Weights and capacities of blowers made from high grade cast iron are shown in TABLE 1.

The rewards for careful design and development of axial-flow positive-displacement type blowers are considerable. The axial blower is capable of much higher pressures than the cross-flow type. Due to the modified internal compression characteristic, blower noise level is materially reduced. Because the blower delivers a known amount of air or gas per revolution, it is ideally suited to applications where fluid metering is important. The blower can, in all cases, develop the pressure needed to overcome system resistance; where such resistance cannot be accurately calculated, as in pneumatic conveying, this blower charateristic becomes highly desirable.

They Say . . .

"Scientific achievement is a dynamic and not a static affair. We must run fast to stay where we are; to move ahead we must run still faster"—DR. HALDON A. LEEDY, *director, Armour Research Foundation.*

"Unconsciously, we are always seeking to measure phenomena; and when we cannot measure them we make the mistake of ignoring or neglecting the qualitative influences in human affairs which are not measurable"—ROBERT W. ELSASSER, *management analyst.*

Automatic Brake Control

. . . prevents aircraft wheel skidding

By Arthur J. Bent
Westinghouse Air Brake Co.
Wilmerding, Pa.

SHORTER stopping distances for aircraft along with prevention of undue tire wear and wheel sliding, are achieved through the use of a new device known as the "Decelostat Controller." As adapted to aircraft this device weighs 3½ pounds and is 6 inches in diameter.

The operating principle of the controller equipment is based on the relation of the deceleration rate of an energy wheel to the deceleration rate of the airplane landing wheel or axle. Under normal landing conditions, the energy wheel in the Decelostat will remain in synchronism with the landing wheel. Should a rate of retardation in excess of a predetermined value occur, the energy wheel will over-travel, operating the Decelostat valve to interrupt the brake pressure and effect a release of the brakes. When the landing wheel and the Decelostat energy wheel have regained synchronism the brake pressure is restored.

Normally positioned on the outboard side and at the centerline of each airplane wheel, the unit, *Fig.* 1, rotates directly with the wheel. Its valve is mounted at a stationary point on the wheel or strut. Connection between the valve and the controller is by a lever arm. On "touchdown," as the controller housing comes up to speed with the airplane wheel the clutch spring will create a force tending to cause the bearing ring, clutch, ring gear, ring washer, and housing to rotate together.

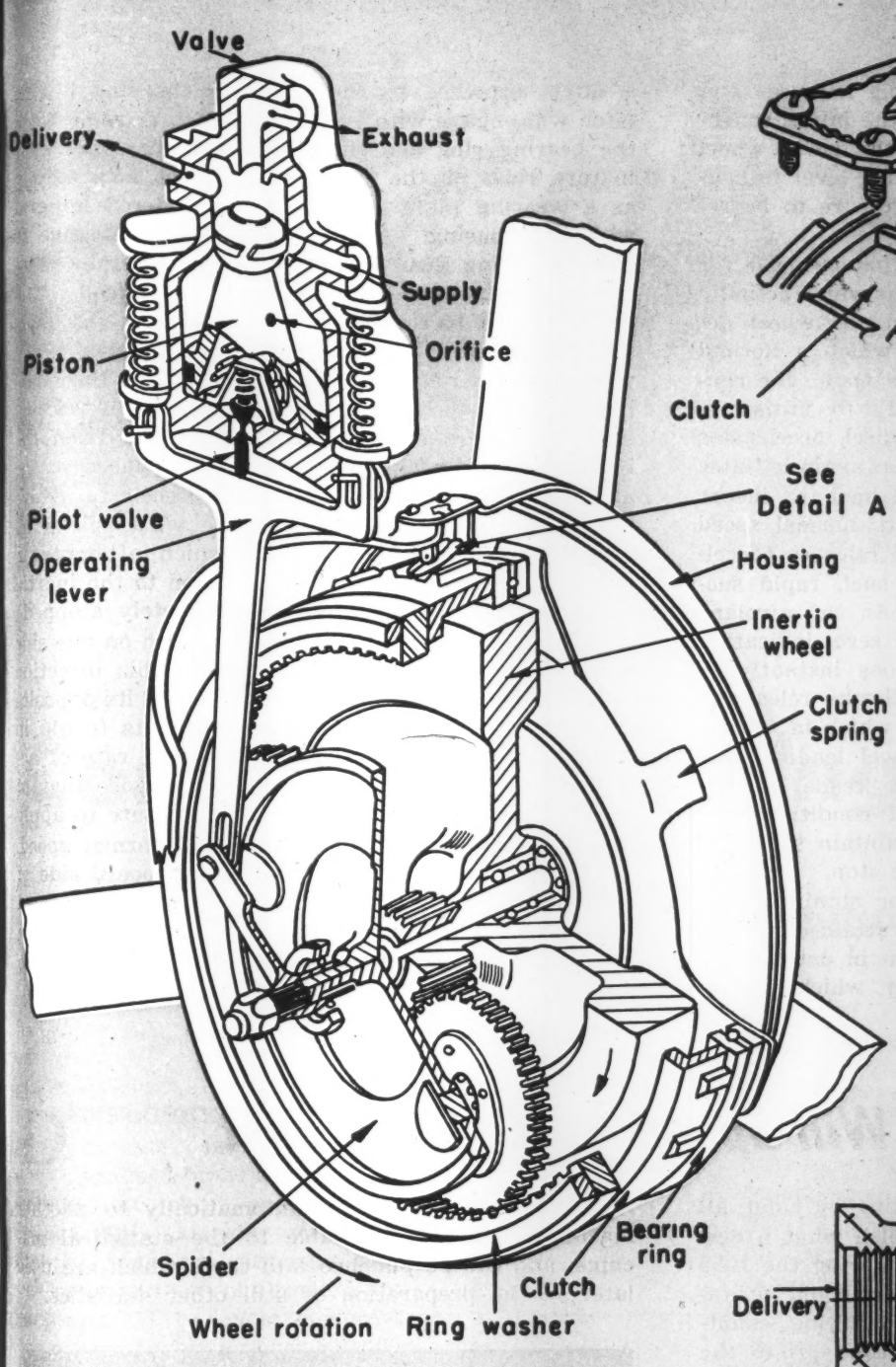
At this instant, however, the inertia wheel is at rest. This inertia wheel is connected to the ring gear through idler pinions. During the initial part of plane wheel acceleration, when the acceleration rate setting of the Decelostat valve is exceeded, the idler pinions have carried the spider and its shaft to the extent of travel of the valve lever arm (which limits the distance through which the operating lever can move). Since the force of the clutch spring is less than that required to "pick-up" the inertia wheel under the initial high rate of wheel acceleration, the ring gear will slip between the clutch and the ring washer. Because of the planetary action, the inertia wheel will be driven in the opposite direction from and at a speed seven times greater than the ring gear. When the inertia wheel has been brought up to full speed, the springs on the valve will force the operating lever back to its neutral position. At this instant the housing, clutch spring, bearing ring, clutch, ring gear, and ring washer are traveling at the same speed and in the same direction as the airplane wheel. The spider and its shaft and the valve-actuating lever arm are stationary while the idler pinions drive the inertia wheel. When brake pressure is applied to the valve, *Fig.* 2, it will equalize on both sides of the piston through the orifice, allowing the piston spring to keep the piston in its upper position, sealing off the exhaust port and connecting supply pressure to the brakes through the delivery port. With the operating lever in neutral, the pilot valve remains seated by its spring and fluid pressure.

Excessive Deceleration Releases Brakes

As the wheel starts into a slide, the Decelostat housing will slow down. For ease of explanation, assume the wheel stops, which means the housing will also stop. The inertia wheel, now driving the pinions, will carry the spider and its shaft and the lever arm clockwise as far as the valve-operating lever will permit, *Fig.* 3*a*. The operating lever pivots about the left-hand pin, thus opening the pilot valve. Pressure will then be exhausted from the underside of the valve piston, moving it downward to cut off supply pressure and opening the delivery port to exhaust, releasing the brakes.

As the brakes are released, the airplane wheel will again pick up speed. Again for ease of explanation, assume the inertia wheel has stopped. Driven by the housing, the ring gear will again move the spider and its shaft, this time counterclockwise, to the op-

*This article is based on a paper presented at the SAE National Aeronautic Meeting, Los Angeles, October 5-8, 1949.



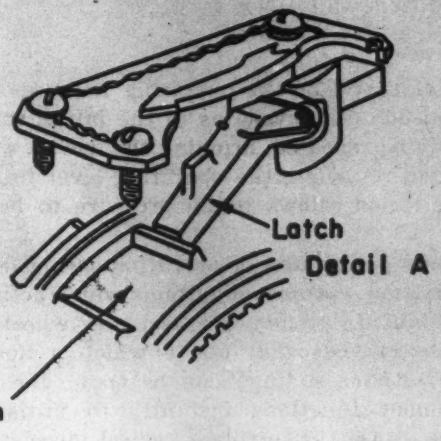
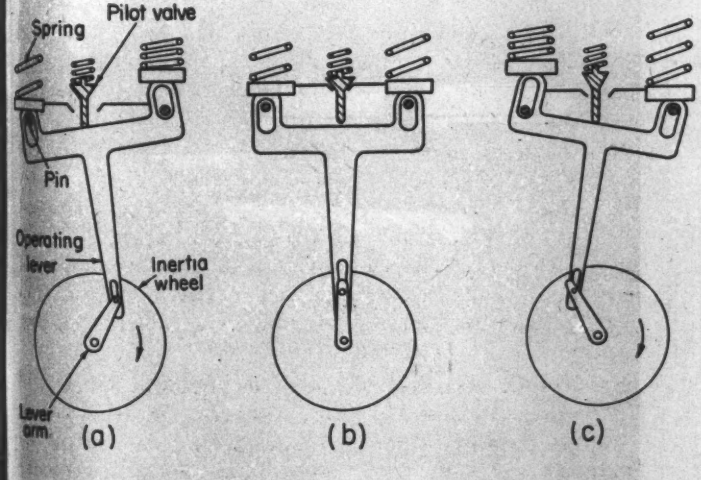
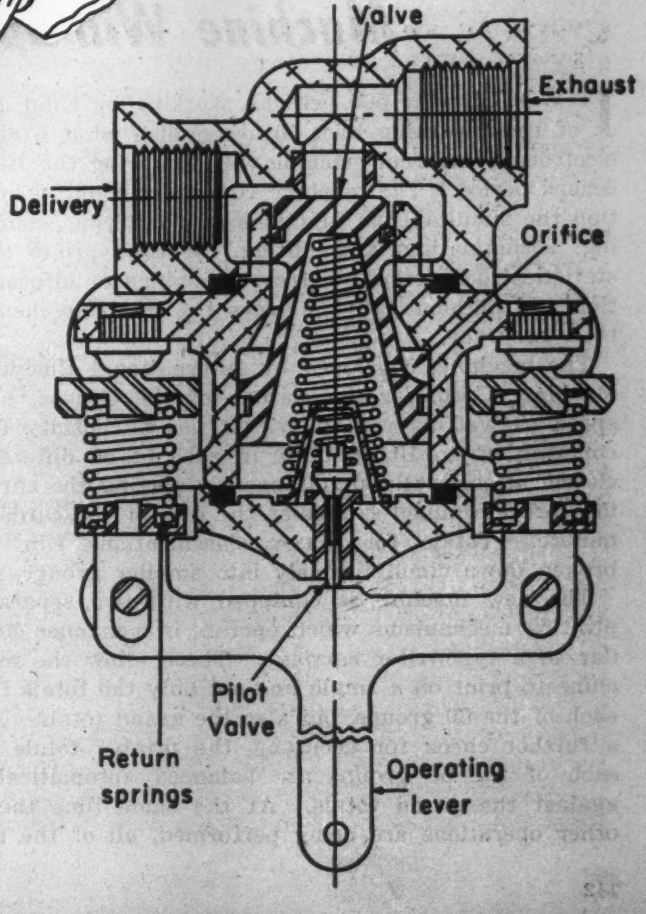


Fig. 1 — Left — Partially sectioned view of Decelostat showing valve-operating lever splined to spider. With wheel rotation as shown, valve is in position to release brakes until wheel has accelerated after excessive braking condition

Fig. 2 — Below — Cross-section of Decelostat valve. Pressure inlet to valve, not shown on drawing, admits fluid between upper and lower seal rings of cone-shaped piston

Fig. 3—Left, below—Sketch illustrating three positions of the operating lever: (a) Deceleration condition, when wheel begins to slide; (b) valve in neutral position, permitting normal braking; and (c) acceleration conditions where wheel is recovering from excessive braking





posite limit of travel of the operating lever, as seen in *Figs.* 1 and 3*c*. The cycle, as in the initial touchdown, will then be repeated, bringing the inertia wheel up to speed and returning the operating lever to neutral, *Fig.* 3*b*, which allows brake pressure to be reestablished.

The foregoing description of operation assumed, for ease of explanation, extreme conditions which actually are never obtained. When the airplane wheel deceleration rate exceeds that above which a normal stop (a stop without sliding) can be made, the controller equipment functions instantly to initiate a brake release. As the airplane wheel accelerates back to its normal speed, the Decelostat again initiates a brake release, as previously explained, to insure against full brake being applied until normal speed has been obtained. These two brake releases (deceleration and acceleration) occur in such rapid succession that they appear as one. As the airplane wheel acceleration rate decreases to zero, indicating normal speed, the controller functions instantly to restore full brake. The degree of brake release is dependent on the time for the cycle which in turn is dependent on ground coefficient, wheel loading, and brake pressure. Since the Decelostat "reads" the action of the wheels individually, all conditions are automatically compensated for to maintain the maximum retarding force throughout the stop.

To minimize the time required for obtaining full brake after the airplane wheel has attained normal speed, the clutch arrangement shown in detail *A* of *Fig.* 1 has been included. The cover, which mounts a latch, attaches to the controller housing. This latch will engage with the clutch which rides between the bearing ring and the ring gear. The ring gear in turn rides on the ring washer which acts merely as a wearing plate and may be considered integral with the housing. As the airplane wheel begins to slide, the ring gear will be driven counterclockwise by the inertia wheel as previously explained. The clutch is free to rotate in this direction on the bearing ring and will be carried with the ring gear which will slide over only the ring washer. Thus the housing can drive the ring gear through only one friction element. Therefore, the energy extracted from the inertia wheel during a slip or slide is reduced to the minimum necessary to operate the Decelostat valve plus a reasonable margin. As the wheel picks up again, however, the ring gear (which attempts to remain stationary due to its connection to the inertia wheel which is assumed to be completely stopped) will be picked up by friction of the clutch on one side which is turned with the housing in this direction through the latch and the ring washer on its opposite side; thus imposing two friction elements to aid in bringing it up to speed. By this means, rate of acceleration of the inertia wheel will be twice that of deceleration. This will allow brake pressure to apply closer to the time the wheel reaches normal speed.

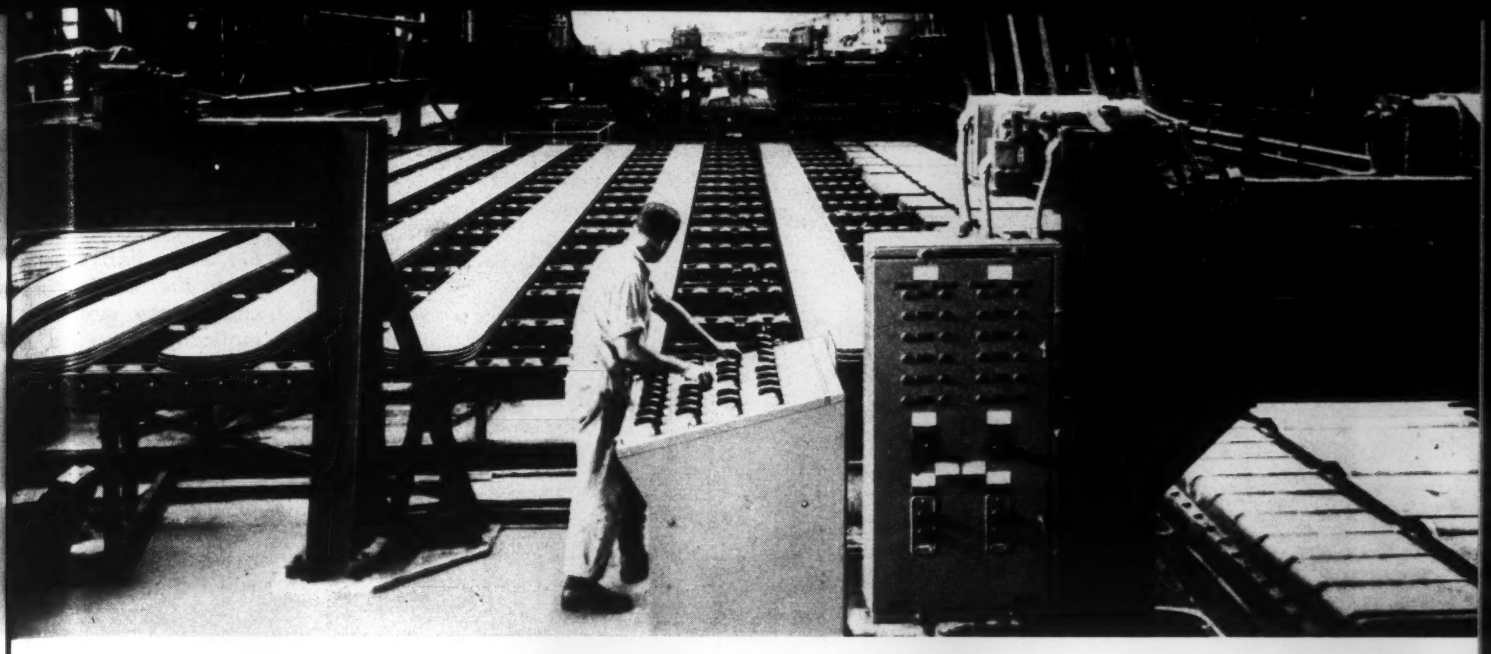
To accommodate mounting on the outboard side of either left or right wheels the latch may be turned 180 degrees by removing the four screws holding the latch cover and placing the arrow on the cover in the direction of wheel rotation.

Machine Will Speed Up Census Count

IT WOULD take 500 persons, working by hand, all of their working lives to accomplish what a new electronic statistical machine will do during the 1950 census period. The machine combines in one operation the simultaneous functions of classifying, counting, accumulating, and editing. It then prints the statistical data resulting from groupings of information and automatically balances the totals to insure their accuracy.

The machine, developed by International Business Machines Corp. for the Bureau of the Census, has speed as well as versatility. It has a capacity for counting up to 10,000 units in each of 60 different classifications while simultaneously sorting the cards into predetermined groups at the rate of 450 cards a minute. Totals for major classifications can be broken down simultaneously into smaller groups.

The new machine is equipped with two separate printing mechanisms which operate in a manner similar to a typewriter carriage. These allow the machine to print on a single line not only the totals for each of the 60 groups, but also the grand totals. As a further check for accuracy, the printed totals of each of the 60 groups are balanced automatically against the grand totals. At the same time these other operations are being performed, all of the information can be relayed automatically to another machine connected by cable to the statistical machine, and can be punched into cards which are used later in the preparation of still other statistics.



Continuous Casting Machine

. . . increases mill production

DEVELOPMENT of the continuous casting process to produce brass slabs for cold rolling into sheet and strip together with extensive mechanization of handling equipment make the new strip mill of Scovill Manufacturing Co. the most modern in the world. Involving over $10,000,000 in plant and equipment the mill, *Fig.* 1, capable of producing longer sheets and strip of a more uniform quality.

Heart of the new mill is the continuous slab casting machine based on the Junghaus-Rossi process and shown diagrammatically in *Fig.* 2. Metal which is to be cast is melted

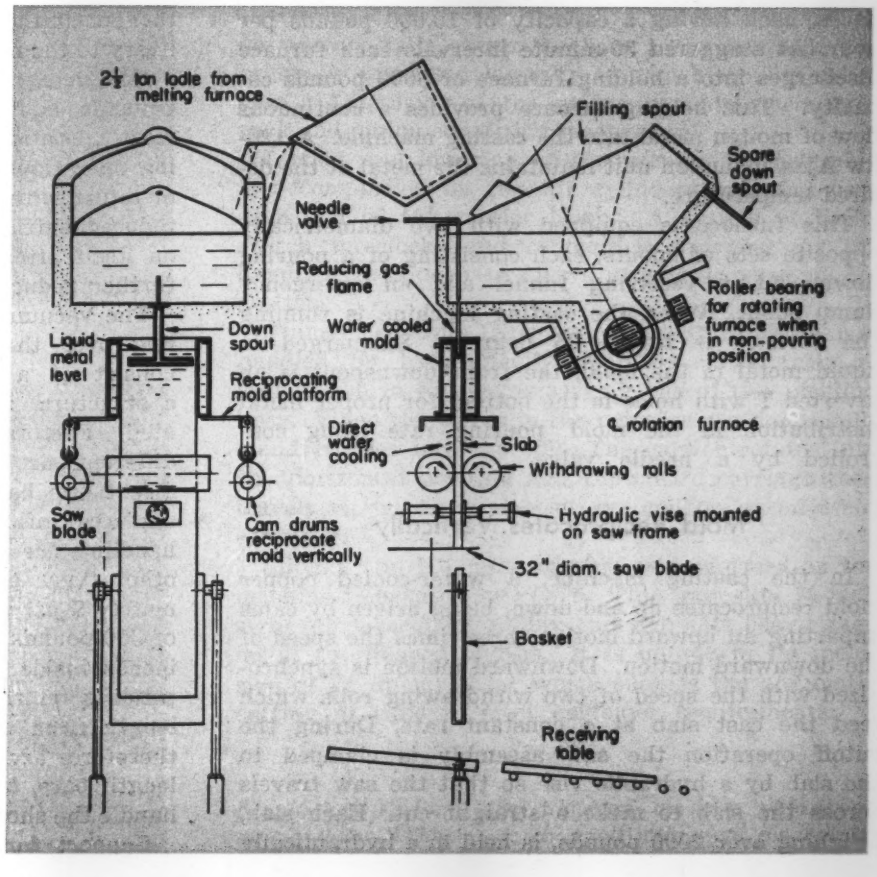


Fig. 1—Above—Over one-quarter mile in length and one hundred forty feet wide, Scovill's new continuous strip mill turns out the heaviest nonwelded brass coils ever produced

Fig. 2—Right—Schematic drawing of the continuous slab casting machine, developed from the Junghans-Rossi process for casting bars

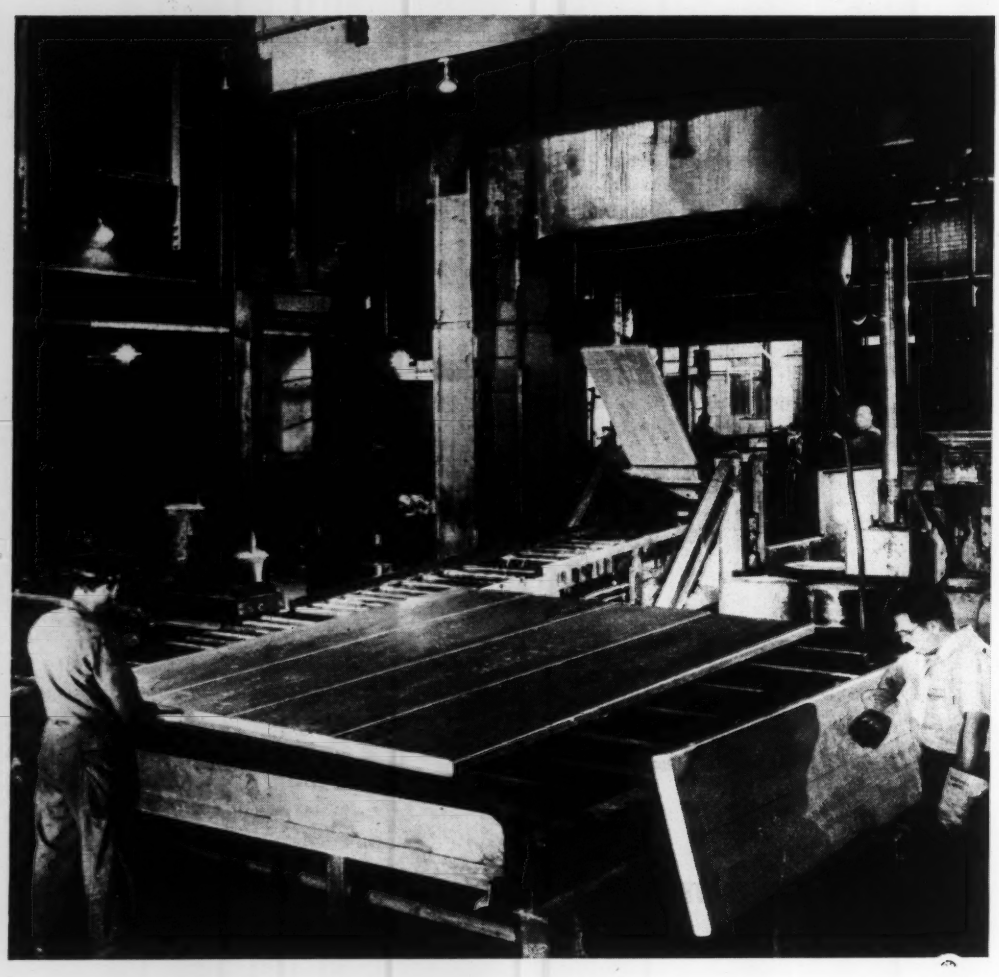


Fig. 3—As slabs emerge from the casting machine, they are automatically sawed to length for delivery to the strip mill

in three 1000-kw low-frequency induction type furnaces, each having a capacity of 10,000 pounds per hour. At staggered 30-minute intervals each furnace discharges into a holding furnace of 9000 pounds capacity. This holding furnace provides a continuous flow of molten metal into the casting machine. A 120-kw Ajax induction unit maintains the metal at the desired temperature.

This furnace is equipped with two diametrically opposite sets of spouts, each consisting of a pouring downspout, a receiving funnel and an emergency dump spout. When the casting machine is running the furnace is tipped 25 degrees. Submerged in liquid metal in the mold, the front downspout is an inverted T with holes in the bottom for proper metal distribution in the mold, pouring rate being controlled by a needle valve.

Mold Reciprocates Vertically

In the casting machine, a water-cooled copper mold reciprocates up and down, being driven by cams imparting an upward motion three times the speed of the downward motion. Downward motion is synchronized with the speed of two withdrawing rolls which feed the cast slab at a constant rate. During the cutoff operation the saw assembly is clamped to the slab by a hydraulic vise so that the saw travels across the slab to make a straight cut. Each slab, weighing over 2000 pounds, is held in a hydraulically operated basket, *Fig.* 3, which is lowered and tilted to deposit the cut slab on a receiving table for delivery to the mill.

Completely mechanized handling with conveyors and transfer equipment makes it possible to perform most operations from control stations. During rolling operations, the slabs are transferred for stacking or return with vacuum-cup handling equipment. When reduced sufficiently in thickness, the sheet is coiled on itself after passing through forming rolls. After further reductions, the strip is wound on mandrels.

The vacuum-cup pilers and unpilers, *Fig.* 4, travelling over the entry, delivery and transfer tables, consist of a series of suction disks mounted on a structural supporting member, hydraulically operated. Factors such as required speed in handling different size bars, need for annealing several different size bars and prevention of damage to metal surfaces influenced the decision to adopt vacuum handling for transfer of flat bars in preference to other types of handling equipment. Using approximately 7 psi vacuum, each cup has a lifting capacity of 350 pounds, there being an area of about 50 square inches inside the rubber seal ring of the cups. Depending on the pass, the 2000-pound bars vary in length from about 9 to 64 feet. The vacuum cups, therefore, are sectionalized to accommodate various length bars, their lifting capacity being adequate to handle the shortest bar.

Support for the vacuum-cup beam is a traveling

Fig. 4—Right—Vacuum-cup system to transfer individual bars to the mill entry table where they are entered in the rolls by a hydraulic pusher on the power feed entry table. Vacuum lifts are also employed on the discharge side of the mill for return to entry side of mill, to end cropping shear or to annealing furnace

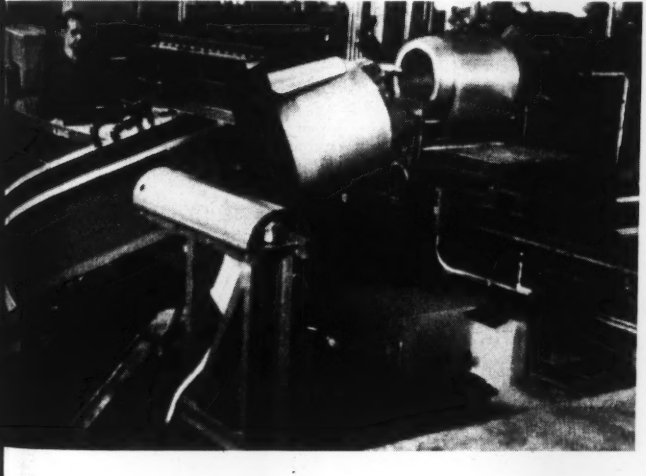


Fig. 5 Left—Hydraulically operated transfer unit transfers coils to pickling line, handling strip up to 30 inches wide and up to 64 feet long

structural bridge with trucks at the ends supported on runway rails above the bars to be handled. The bridge is traversed laterally by two hydraulic cylinders. Alignment of the bridge is maintained by a rack and pinion equalizing mechanism.

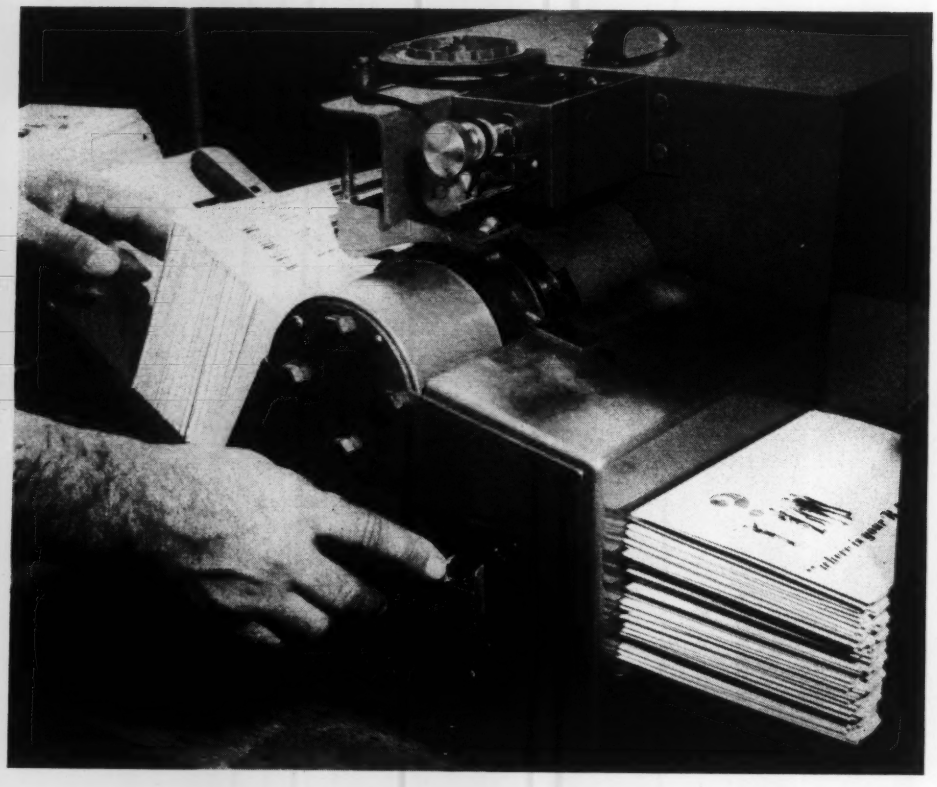
Lifting and lowering of the vacuum-cup assembly is accomplished by two air cylinders mounted near each end of the carrier beam. A system of limit-switch interlocks and controls is provided for the handling equipment to insure proper sequence of operation.

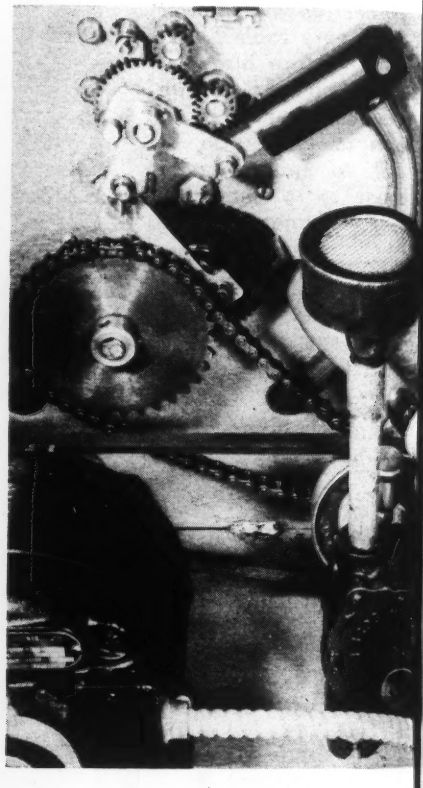
Transfer of coils from one conveyor to another is handled by hydraulically operated units such as that shown in *Fig.* 5 for serving one of two pickling lines. When the coil is in the transfer position a split mandrel rises into the coil. The carrier rotates into the horizontal position and the entire carriage then travels on tracks to deposit the coil on an adjacent conveyor.

Slitting and trimming of strip is performed on the machine illustrated in *Fig.* 6. This unit slits ⅜-inch strip for subsequent rolling and also slits heavy gage metal to finished widths. It is unique in its inclusion of an up-cut shear which enables the automatic cutting of coils to meet customer requirements.

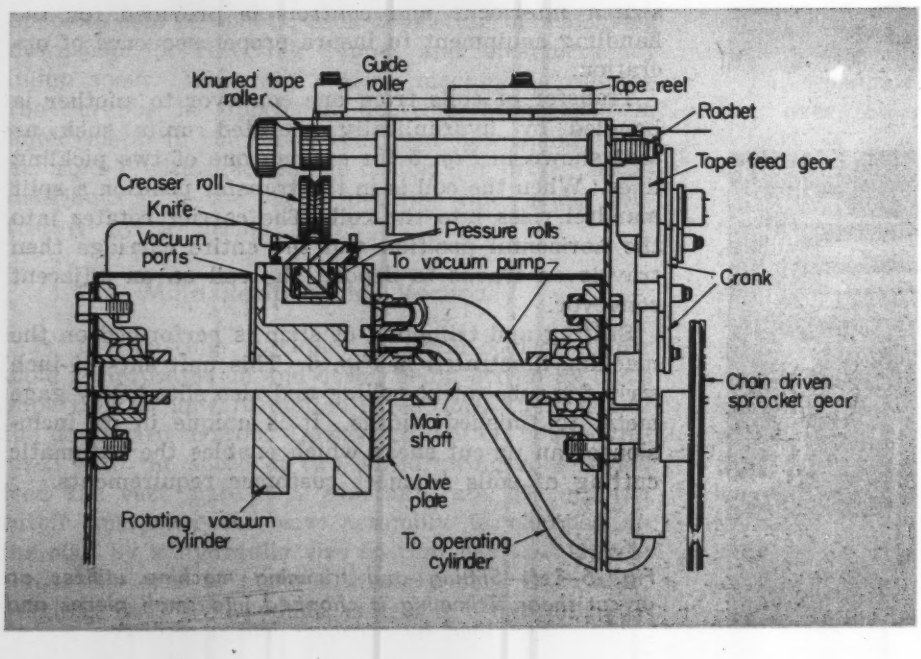
Fig. 6—Left—Slitting and trimming machine utilizes an up-cut shear. Trimming is chopped into small pieces and deposited by conveyor into a receiver

Contemporary





Stock Supply Controls Tape Feed



UNIQUE mechanism automatically stops feeding tape when paper supply runs out in the mailing piece sealer shown in the photograph, left above. The machine applies one-inch long pieces of ¼ to ½-inch wide tape to 7200 pieces per hour. Tape is pulled from the reel by knurled roller and then creased by a grooved roller and creasing guide as shown in the drawing at left. The mailing piece is picked up by vacuum ports in a rotating cylinder, carried into the extended tape and then fed between pressure rollers which draw the tape against a stationary knife and seal the piece. When the supply of unsealed pieces is exhausted, the vacu-

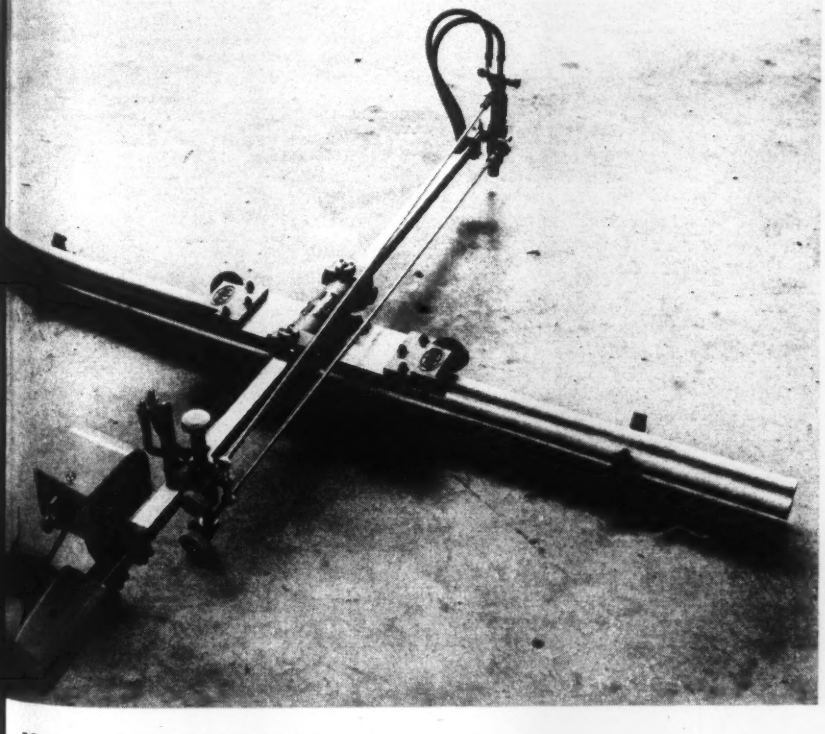
um ports remain uncovered and the tape is prevented from feeding as follows: Vacuum in the rotating cylinder causes a piston in the operating cylinder to be pulled in. This moves a pin on a rachet linkage into contact with a crank driven by the main drive gear so that the tape feed gear is periodically advanced through an arc sufficient to feed one inch of tape.

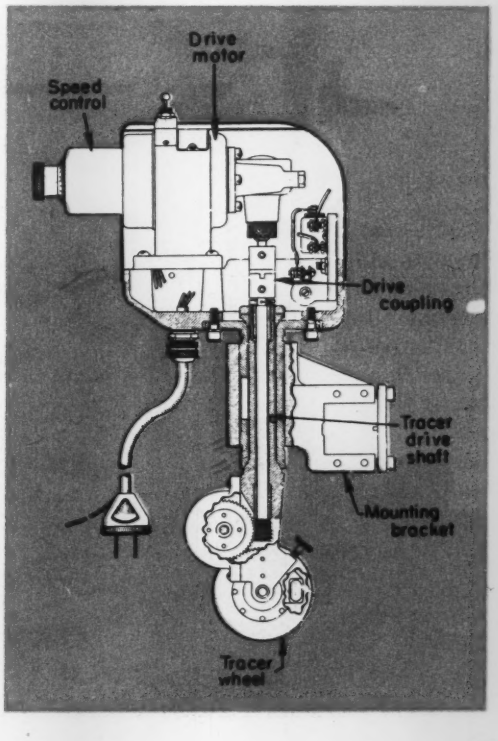
When the vacuum is broken, as occurs when the unsealed pieces are exhausted, the operating piston, shown in the photograph at left, moves out thereby removing the pin from contact with the drive gear crank and stopping rotation of the tape feed gear. Operating sequence is maintained with a valve plate which seals against the rotating vacuum cylinder. Paper sizes from 3 by 3 inches to 6 by 13 inches can be handled. Manufacturer: Minnesota Mining and Manufacturing Co., St. Paul, Minn.

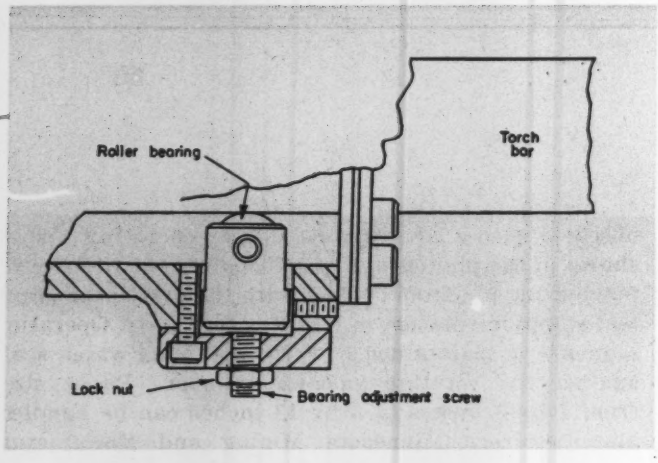
Shape Cutter Employs Variable-Speed Drive

USING a tubular rail for a track, the portable shape-cutting machine shown, below, cuts metal up to eight inches thick over an area 32 by 56 inches. The machine consists of a carriage, a roller housing, and a 1½-inch square bar which carries a tracer on one end and a cutting torch on the other. Torch movement is governed by the motorized, manually-controlled tracer seen in the cross section drawing at the right below. The tracer wheel is driven by a 1/25-hp, governor-controlled variable-speed motor operating on 115-volt, 25 to 60-cycle a-c or 115-volt d-c and provides cutting speeds from three to 30 inches per minute. The tracer wheel is guided manually to follow a line drawing or pattern of the shape to be cut.

A torch, mounted on the opposite end of the bar



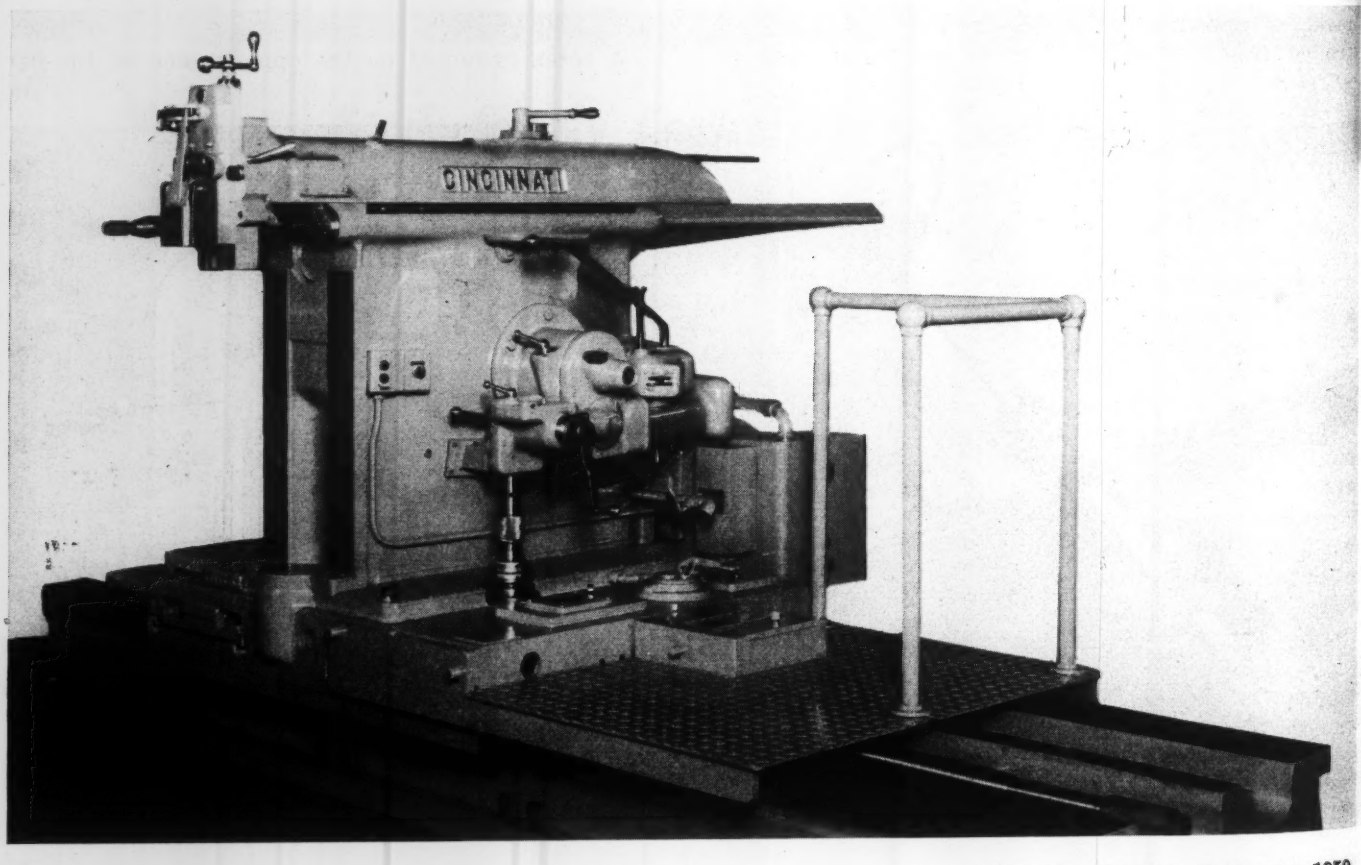


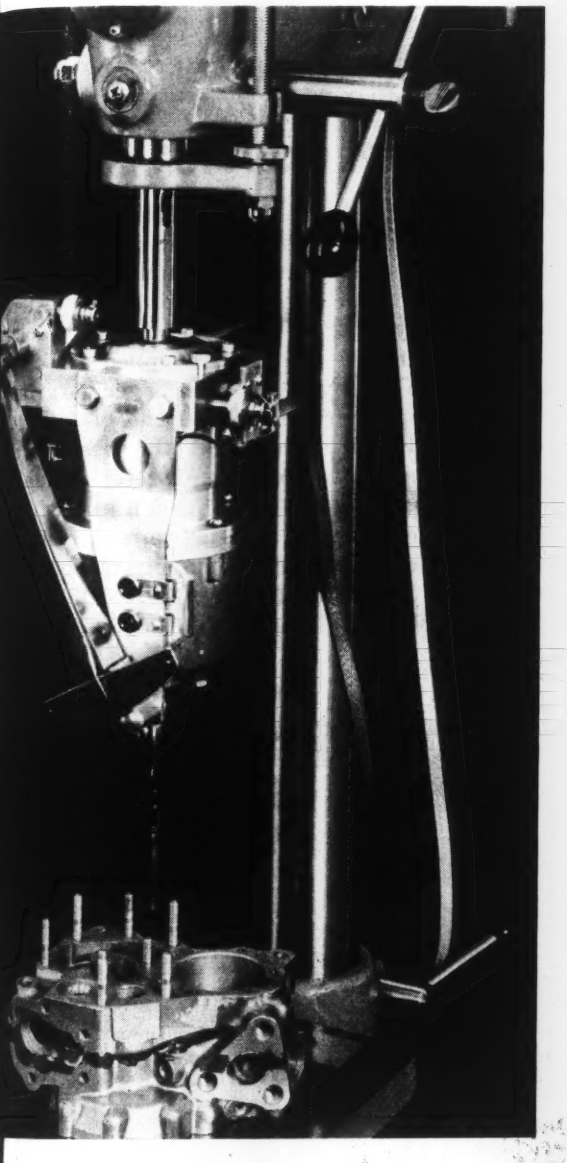


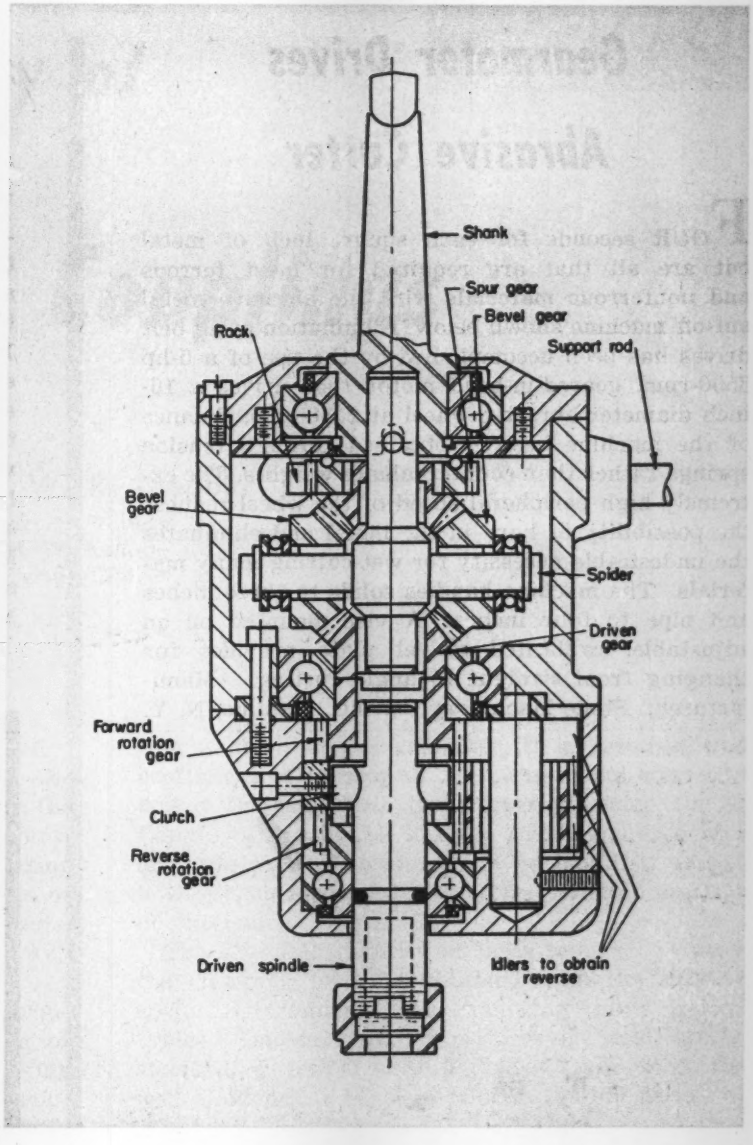
from the tracer, follows the same outline described by the tracer. Machine motion in one direction is provided by movement of the 1½-inch bar on bearings mounted in a roller housing as shown in the drawing, left. Motion in the other direction is provided by movement of the carriage along the tubular rail. An idling wheel just forward of the tracer can be lowered to take the weight of the machine from the tracer wheel. Remote controls for the cutting oxygen and for raising and lowering the torch are located near the tracer. Total weight of machine and track is 145 pounds; length of the cutting area can be increased in multiples of 6 feet 8 inches by adding extensions to the tubular rail assemblies. Manufacturer: Air Reduction Sales Co., New York, N. Y.

Shaper Travel Increases Machining Capacity

TRAVELING shaper shown, below, employs the method of travel of a boring mill to machine surfaces requiring to 8 feet of table travel. The machine is equipped with hand or power feed and a power rapid traverse of the table. Two automatic oiling systems are used—one for ram, feed and drive mechanisms and the other for the saddle and ways. A foot operated pump is provided for re-establishing the oil film after the machine has been idle. Machine specifications: Ram stroke, 36 in.; ram speeds, 8 to 102 strokes per minute, vertical adjustment of tool slide, 9 in. The operator rides on a platform attached to the saddle. Manufacturer: The Cincinnati Shaper Co., Cincinnati, O.







Differential Mechanism Drives Studs

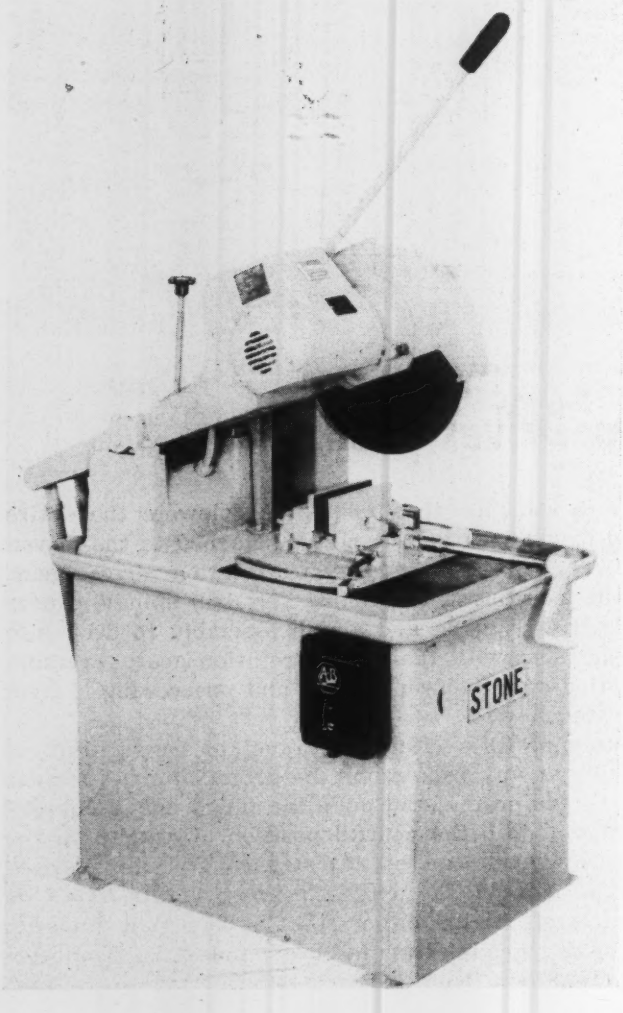
DIFFERENTIAL action of a set of bevel gears is employed in the torque indicating stud driver shown in the photograph, above. The device, driven by a drill press, air motor or electric drill, maintains a uniform torque on all studs while increasing production through use of an indicating system employing red and green lights. The green light shows until the preset torque has been reached, at which time it goes out. Should the stud be set too tight, a red light indicates that condition.

One half of the differential assembly is geared to a standard torque wrench, as shown in the drawing above, through a spur gear and rack and to indicate applied torques. The other half, driven by the shank and spider assembly, is rotated in the same direction as the shank by the planetary action of the bevel gears. Depressing the drill press spindle (assuming unit is attached to a drill press) lowers the entire stud driver unit until a clutch attached to the driven spindle engages the forward-rotation drive gear. When the stud is set, lifting the drill spindle causes the driven spindle and clutch assembly to drop into engagement with the reverse-rotation gear, reversing rotation of the driven spindle and unscrewing it from the stud.

Stopping the downward travel of the drill press spindle at any time stops the driven spindle because the thread on the stud pulls the clutch out of engagement and into the neutral position. Contacts on the torque wrench can be adjusted to give any desired range between the red and green lights. Unit is capable of driving either right or left-hand studs up to ½-13 threads. Manufacturer: Industrial Engineering Co., South Bend, Ind.

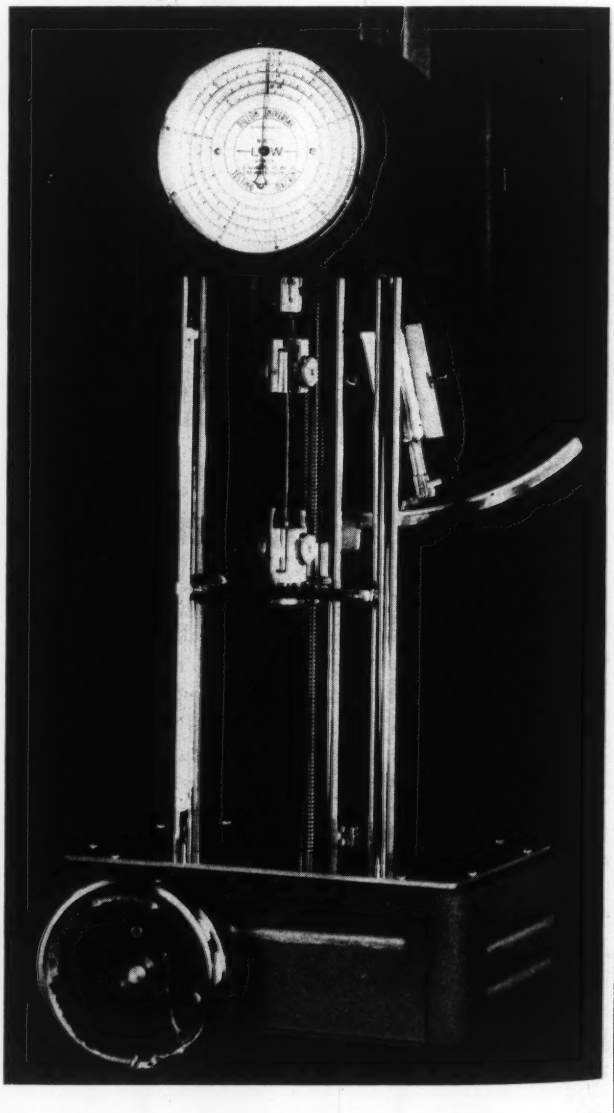
Gearmotor Drives Abrasive Cutter

FOUR seconds for each square inch of metal cut are all that are required for most ferrous and nonferrous materials with the abrasive metal cut-off machine shown below. Elimination of all belt drives has been accomplished by the use of a 5-hp 3500-rpm, geared-in-head motor that drives a 16-inch diameter abrasive wheel at 2380 rpm. Balance of the machine head is obtained through tension springs rather than counterbalance weights. The extremely high peripheral speed of the wheel reduces the possibility of burn in the metal and eliminates the undesirable necessity for wet-cutting many materials. The machine handles solids to three inches and pipe to four inches. A vise mounted on an adjustable, calibrated swivel plate provides for changing from straight to angle cutting. Manufacturer: Stone Machinery Co. Inc., Manlius, N. Y.



Universal Tester Is Hand Operated

HAND operated through a worm and gear drive, the low-cost universal testing machine, below, is accurate to one-half of one per cent. The tester has four capacity ranges—zero to 10, 25, 50 and 100 pounds. Standard grips are supplied for flat specimens up to ⅛ by 1¼ inches, special grips are available for rubber, wire, wood and other materials. The indicator remains at the peak load reached after a specimen breaks until reset manually; elongation readings are taken from a graduated scale mounted on one of the pressure columns. Maximum opening between gripping heads of the standard model is 14¾ inches; weight, 85 pounds. Manufacturer: W. C. Dillon & Co. Inc., Chicago, Ill.



Torque Capacity of Bolted Couplings

By W. R. Leopold
Special Products Div.
M. W. Kellogg Co.
Jersey City, N. J.

TWO forces inherently present in any bolted coupling may be used to transmit torque—the shear capacity of the coupling bolts, and the frictional capacity of the clamped surfaces. Employing the shear capacity of the bolt in transmitting the torque requires the use of a series of dowels or precision-fit bolts, which results in costly and time-consuming procedures in initial assembly as well as in bolt replacement after service.

A more favorable method of transmitting torque in a bolted coupling makes use of the clamping or frictional capacity of the coupling. In transmitting torque in this manner, a reasonable and easily maintained hole-and-bolt tolerance results in lower production costs and an assembly having a greater degree of safety since bolt fit is not critical. Further, more economical use of bolts results because frictional capacity is obtained automatically, to some degree, when preloading the bolts to a stress level greater than the anticipated axial load imposed upon the coupling, in order to eliminate flange separation and consequent bolt bending stresses.

The following expression defines the frictional torque capacity of a bolted coupling:

$$T = \sigma A R N \mu$$

where σ = tensile stress in bolt, psi; A = minimum cross-sectional area of bolt, sq in.; R = radius of bolt circle, in.; N = number of bolts; and μ coefficient of friction between the bolted surfaces.

The chart on the following page is derived from this equation and indicates the required clamping load necessary at any bolt circle diameter in order to obtain a given torque capacity. It is assumed that a coefficient of friction of $\mu = 0.10$ exists between the bolted flanges. This is an average value for steel flanges of reasonable surface finish and free of dirt and lubricant. The chart can be modified as noted, however, to incorporate any other desired coefficient of friction.

The size and quantity of bolts required to provide the clamping load, as obtained from the chart, are easily determined. The following table indicates typical load-carrying capacities of steel straight-shanked or necked bolts having a hardness of Rockwell C 32 and a tensile yield of 107,000 psi:

Bolt Size	Torque* (in.-lb)	Clamping Load (lb)
¼-28	80-85	2190-2330
5/16-24	160-175	3500-3840
⅜-24	225-250	4430-4920
7/16-20	375-400	6450-6890
½-20	550-600	8260-9020
9/16-18	825-875	10950-11600
⅝-18	1125-1200	13650-14550

* Engine oil thread lubricant.

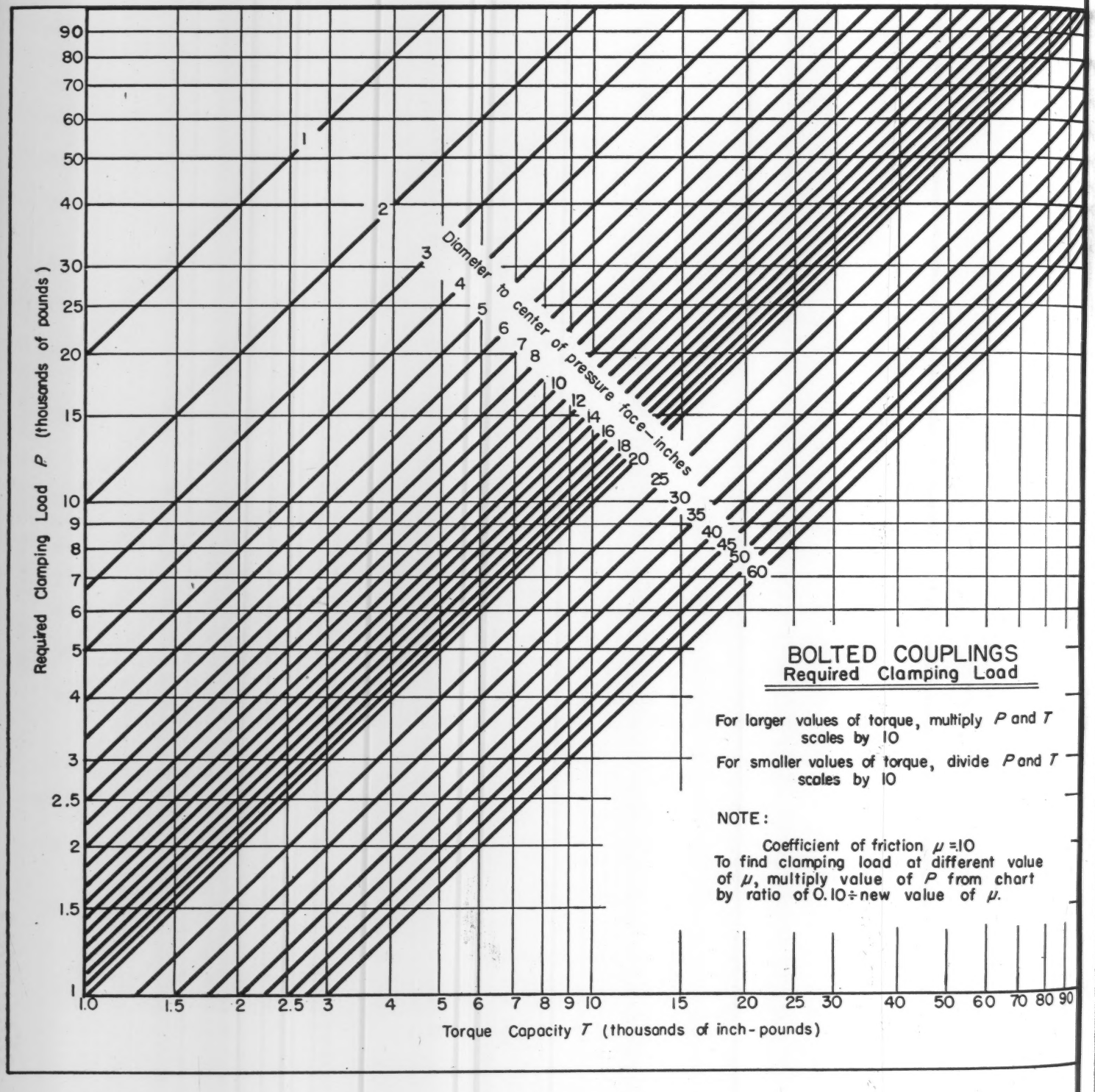
These values may be modified, of course, to accommodate various materials having different yield strengths.

EXAMPLE: If the torque to be transmitted is 30,000 in.-lb and the pressure face diameter is 6 in., find (a) clamping load required and (b) number and size of bolts necessary.

From chart, at intersection of 30,000 in.-lb and 6 in. line, the clamping load required is P = 100,000 lb. From bolt-load table, assuming ⅝-in. bolt, 100,000/13,650 = 7.34, say 8 bolts required.

Material for this data sheet was compiled for the Wright Aeronautical Corp.

Data Sheet (Couplings)

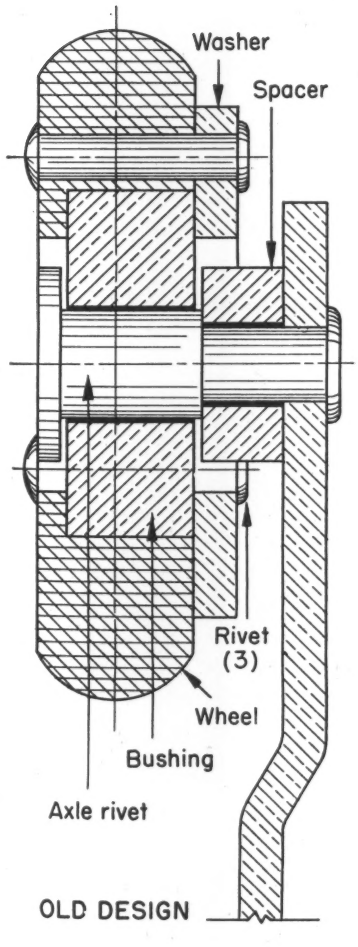


PRODUCTION AND DESIGN

Modern Practices in Manufacture

FULL consideration of the possibilities of design with production operations in view invariably results in a minimum cost product. Consideration of the basic limitations of production methods is but one phase. Design to eliminate unnecessary parts and assembly operations must also be kept in mind. The Metal Products Corp. track wheel shown in the accompanying drawing is an excellent illustration.

The new design not only eliminated three rivets, one large washer and one spacer but reduced the weight 0.38 ounces or 19 per cent which reflected a considerable saving in prepaid shipping costs. Maintenance on the washer die, riveting and drilling fixtures, and cost of dies and drills was eliminated as a result, along with tolerance difficulties experienced in production of the parts. Use of a single Truarc retaining ring permits faster assembly of the components and improved performance owing to the greater bearing area. Actual reductions in material, labor and overall costs can be seen from the tabulations.



Labor Savings

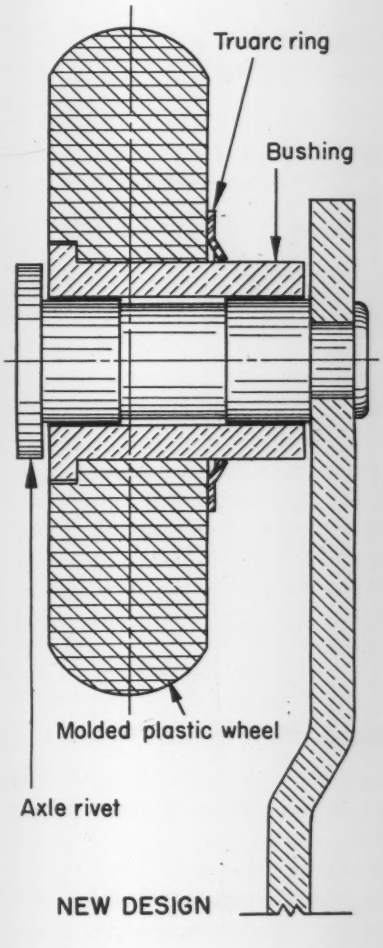
	Old Min	Old Cost	New Min	New Cost
Drill wheel (3 Rivet Holes)	0.23	$0.0042	....	.....
Press bushing into wheel	0.12	0.0021	....	.....
Rivet washer to wheel	0.46	0.0111	....	.....
Punch washer	0.017	0.00033	....	.....
Press Oilite bushing into wheel through Truarc (4 at a time)	...	.....	0.100	$0.00173
Inspection	0.37	0.0064	0.185	0.00320
Totals	1.197	$0.02413	0.285	$0.00493

Saving 0.912 Min = 76.2%, $0.0192

Total Savings

	Old	New
Total Labor	$0.02413	$0.00493
Wheel	0.1402	0.0934
Bushing	0.0334	0.0173
Washer	0.0111	.....
Rivets—3	0.00405	.....
Spacer	0.00721	.....
Axle Rivet	0.0409	0.0241
Truarc Ring	.....	0.00528
Totals	$0.26099	$0.14501

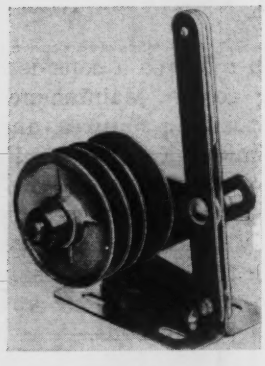
Savings $0.11598 = 44.5%



NEW PARTS AND MATERIALS

For additional information on this new equipment see Page 171

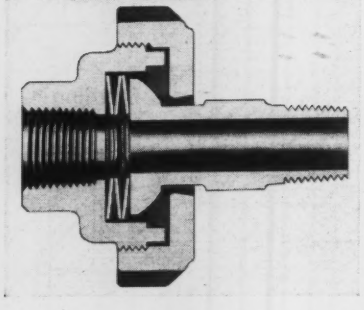
Variable Speed Transmission



Attaining 3.3 to 1 speed range with A-section belts, die-cast Cub variable-speed transmission employs 3½-in. die cast pulleys and stamped steel frame. Die-cast spindle rotates on bronze bushing over stationary steel shaft. This shaft is anchored to pivotal frame and is drilled for forced lubrication of rotating member. Manufacturer: Standard Transmission Equipment Co., 78 W. Union St. Pasadena 1, Calif.

For additional information circle MD 1 on Page 171

Rotary Swivel Pipe Joint



Suitable for swivel and slow revolving applications, this rotary swivel pipe joint operates without leakage at extreme temperatures. Because design eliminates wedge action of ball against gasket, turning torque is reduced to minimum. Small amount of side flexibility minimizes possibility of wear or breakage from side strain. Successful performance has been obtained at continuous rotation up to 30 rpm. Joint will handle practically all fluids and gases including corrosive acids and alkalies. It is presently available in 90-degree angle and straight designs in pipe sizes from ⅜ to 1-in. Manufacturer: Barco Mfg. Co., Dept. 67, 1801 W. Winnemac, Chicago 40, Ill.

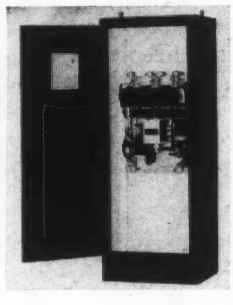
For additional information circle MD 2 on Page 171

Copper Brazing Paste

Applied speedily and with little waste, Cubond copper brazing paste for furnace-joining of parts is produced in two general types: One has a synthetic petroleum base and the other does not change viscosity with changes in temperature. Consistency of the petroleum base paste is sufficiently fluid to permit extrusion from guns without thinning. However, it can be thinned for application by brush, spray or dip. It will not settle, harden or dry in can or on job. Since petroleum-base paste does not thin with temperature rise, it has less tendency to flow away from joint. Manufacturer: Metals Refining Co., 1717 Summer St., Hammond, Ind.

For additional information circle MD 3 on Page 171

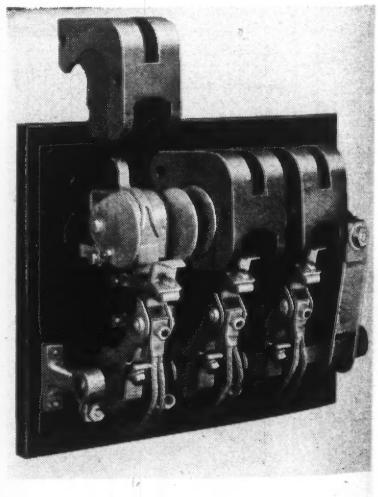
A-C Solenoid Starters



Added to line of bulletin 709 a-c, across-the-line solenoid starters are sizes 6 and 7, rated 600 and 900 amp, respectively. Both units have one-piece magnetic plunger which operates with vertical straight line motion and adjustable thermal overload relays. Fully-enclosed double-break silver-alloy contacts require no cleaning, filing or dressing. Solenoids are energized with direct current drawn from self-contained selenium rectifier. All terminals and wiring are accessible from front. Manufacturer: Allen-Bradley Co., Milwaukee, Wis.

For additional information circle MD 4 on Page 171

A-C Magnetic Contactors

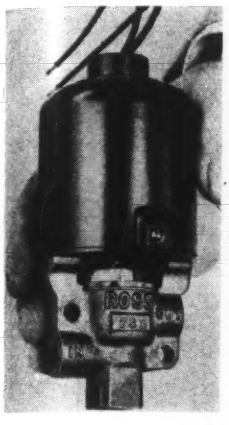


Available in 100 and 150-amp ratings, these a-c magnetic contactors operate on 115 to 550 v at 25, 50 and 60 cycles. Features include fast blowout system which affords high rupturing capacity and arc centering for long arc shield life and fast arc interruption. Single screw clamp device on armature provides adjustment for quiet operation. Main copper contacts are hard-drawn line type, and auxiliary contacts are double-break silver-to-silver bridging type which are insulated from each other. Latter provide both nor-

mally-open and normally-closed positions. Shunts are flexible braided copper, springs are stainless steel, and bearings are lifetime self-lubricating graphite bronze. Manufacturer: Euclid Electric & Mfg. Co., Madison, O.

For additional information circle MD 5 on Page 171

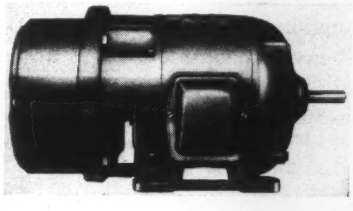
Solenoid Air Control Valve



This quick-operating air control valve of ⅛-in. pipe size is compact and direct-operated by a solenoid. For ⅛-inch pipe connections, it is supplied in both normally-open and normally-closed models, either straightway or three-way and with in-line, side, bottom or panel mountings. Straightway units are suitable for control of liquids since corrosion-resistant materials are used throughout. All parts are easily replaceable. Instantaneous action makes the valve adaptable to a wide variety of industrial applications. Manufacturer: Ross Operating Valve Co., 120 E. Golden Gate Ave., Detroit 3, Mich.

For additional information circle MD 6 on Page 171

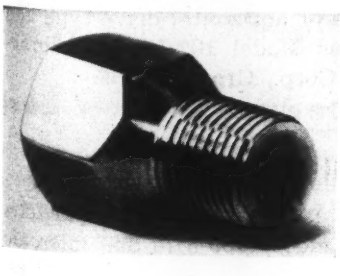
Totally-Enclosed Brakemotor



Available in drip-proof, splashproof or totally-enclosed constructions in ratings from 1 to 60 hp, brake motor is suitable for applications requiring frequent starting and instantaneous stopping. Bonded metal brake linings require no adjustment and are unaffected by heat, cold, dampness, salt water, fungi, grease or oil. All-metal construction of brake disks provides high wear resistance. Brake is available separately for mounting on NEMA standard D-flange motors in frames 203-326 or C-face motors in frames 364-405 with standard double-shaft extensions. Manufacturer: Crocker-Wheeler Div., Elliott Co., Martin St., Jeannette, Pa.

For additional information circle MD 7 on Page 171

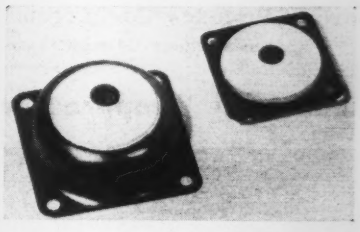
Monel Pressure Snubber



Designed to protect pressure gages and other pressure instruments from shock caused by sudden pressure increase or decrease, Micro Metallic all-Monel pressure snubber has greater corrosion resistance to certain liquids and gases than stainless steel or brass. In addition to cushioning against shock and vibration, snubber filters fluid to prevent foreign matter from entering gage pressure elements. Snubbers are provided in four porosities for use with oil, water or gas or with mercury manometers Provided with ¼ or ½-in. National Pipe Thread connections, snubber fits directly into pipeline and increases its length by about ¾ or 1¼ in. No adapting connections are required and unit is available with other type threads if specified. Distributor: Chemiquip Co., 193 Bradford St., Brooklyn 7, N. Y.

For additional information circle MD 8 on Page 171

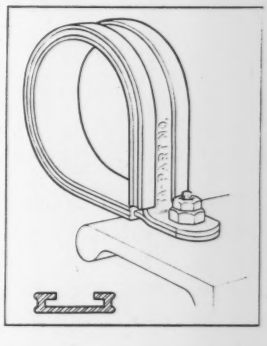
Silicone Antivibration Mounts



Use of silicone rubber in construction of Cohrlastic vibration dampening mounts permits them to carry their loads and absorb disturbing frequencies within temperature range of −100 to 500 F. They will protect delicate instruments in cold of substratosphere where ordinary rubber becomes stone hard. They are equally effective in locations where high ambient temperatures make standard rubber mountings soft and gummy. Available in many sizes of AN instrument series, they can be designed for most services where temperature resistance is required with vibration characteristics of sheer type mount. Manufacturer: Connecticut Hard Rubber Co., New Haven 9, Conn.

For additional information circle MD 9 on Page 171

Self-Bonding Cushion Clamp



Having conductivity 19 to 300 times greater than new bonding specification MIL-B-5087, type TA-70 self-bonding cushion clamps are available in aluminum, steel or stainless steel. These high conductivity clamps are obtainable in all sizes from ⅛ to 6-in. ID in increments of 1/16-in. For quick identification, double beads are added to outside edge of conductive rubber, in addition to complete part identification on each clamp. Manufacturer: Thomas Associates, 4607 Alger St., Los Angeles 39, Calif.

For additional information circle MD 10 on Page 171

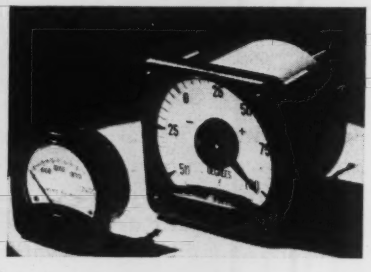
Thermosetting Resin Adhesive

Metals, glass, ceramics plastics, wood and other rigid materials can be joined to themselves or to each other by Adhesive A-1. This thermosetting resin compound contains no volatile solvent and does not shrink or swell upon hardening. No primer coating or open assembly drying is necessary. Adhesive

begins to cure as soon as liquid activator is mixed with resin composition. At room temperature, glue will develop about half its full adhesive strength overnight with Activator A, and with Activator B, in 24 to 36 hours. Full strength develops in about a week. Temperature of 100 F will cure glue twice as fast as room temperature. For many applications, rapid cures can be made in from 1 to 2 hours at 200 F. After curing, glue is resistant to much higher temperatures. Manufacturer: Armstrong Products Co., Argonne Rd., Warsaw, Ind.

For additional information circle MD 11 on Page 171

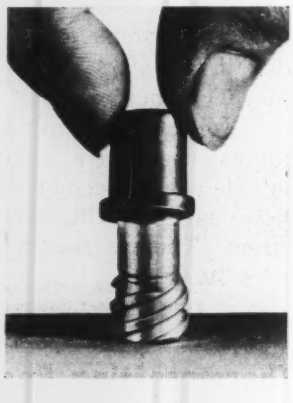
Industrial Temperature Indicators



Included in line of temperature indicators for industrial and laboratory use are cold-end compensated thermocouple thermometers for measuring temperatures up to 3000 F and resistance thermometers for temperatures up to 300 F. The thermocouple type is available in two sizes with 3½-in. or 2½-in. flanges. Both models can be supplied in either square or round molded Textolite cases. Designed for measurement of low temperatures where high accuracy is important, resistance thermometers are furnished in two standard types: DB-15 long-scale instrument and types DD-6 or DD-7 6-inch rectangular, surface and flush-mounted instruments. Manufacturer: General Electric Co., Meter & Instrument Div., Schenectady 5, N. Y.

For additional information circle MD 12 on Page 171

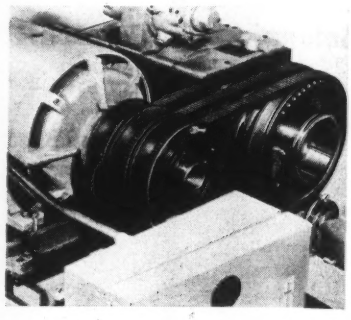
Plastic Grease-Fitting Cap



Designed to fit over ⅜-in. Alemite Dot lubrication fittings, this Electoplastic cap prevents dirt and other matter from lodging on tip. Protection is particularly important for chemical, cement, foundry and similar machinery which is run under dirty or dusty operating conditions, because abrasive matter could be forced easily into fitting and result in scored bearings. Cap is black flexible Vinylite. It is easily applied and removed, holds by friction fit, and is unaffected by oils, grease or gasoline. Manufacturer: S. S. White Dental Mfg. Co., Plastics Div., 10 E. 40th St., New York 16, N. Y.

For additional information circle MD 13 on Page 171

Speed-Control Drive

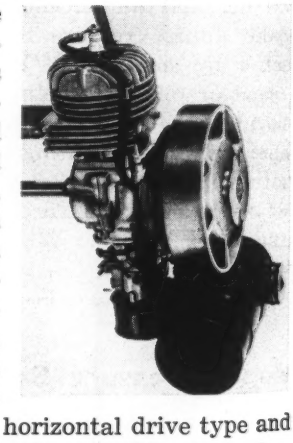


Consisting of Vari-Pitch automatic sheave, companion sheave, wide range Texrope belts and Texslide motor base, speed control unit is particularly suitable for applications requiring frequent speed changes or making adjustments without shutting down drive. It assures easy smooth starting and can be used for speed change ratios up to 2:1. Desired speed variances are obtained quickly by turning adjusting screw on Texslide motor base with ordinary wrench. To increase speed, motor is moved toward driven machine; to decrease speed, it is moved away.

Drive is applicable to high starting torque since it permits belts to ride at small pitch diameters during acceleration. Pitch diameter of sheave is changed as desired by moving angular-faced disks toward or away from each other. Automatic belt tension stabilizer provides proper sidewall pressure and belt tension regardless of position of belt in groove. Sheave accommodates standard motors from 1½ to 40 hp with speeds from 900 to 1800 rpm. Manufacturer: Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.

For additional information circle MD 14 on Page 171

Lightweight Gasoline Engine



Offering portable source of rotary power, Model 102-VS 1-hp gasoline engine is similar in design to manufacturer's standard vertical shaft Model 2000. Model 102-VS, low-cost engine, weighs only 14 lb, less than half that of most engines in this power class. It is air-cooled and employs a flywheel magneto. Companion Model 101 representing a modification of the horizontal 1-hp Model 1000 is of horizontal drive type and has the same features as Model 102-VS. Manufacturer: Power Products Corp., Grafton, Wis.

For additional information circle MD 15 on Page 171

In-Line Micronic Filter

Having replaceable element that filters particles as small as 40 microns, model 480-3 in-line micronic filter is suitable for 3000-psi operating pressure. Pressure drop is 25 psi at 10-gpm flow using SAE

JOHNSON BRONZE

SLEEVE BEARING DATA

Bearing DESIGN

SLEEVE BEARING DATA

Standard Tests for Sleeve Bearings-2

AS pointed out in the preceding data sheet—"Standard Tests-1"—the prime reason for the large number of tests employed is simply to assure the user that he is getting the greatest bearing performance possible for his money. This is necessary in Sleeve Bearings not only because there are so many types of bearings available but also because it is possible to so design any type to secure all the necessary properties. Cast bronze is a good example. There are approximately one hundred separate and distinct alloys from which to choose. If plasticity and/or embeddability is a chief requirement the usual method is to increase the lead content. If greater hardness is required, the lead content is lowered, then tin, or nickel, or manganese, for instance, is increased.

One of the chief points to remember in specifying sleeve bearings is that they can be "tailor-made" to suit practically any application. The only requirement is that we first determine all of the pertinent operating factors.

Johnson Bronze Alloy No.	PHYSICAL PROPERTIES			
	(1) Wear Rate (dry)	(2) Coefficient of Friction (dry)	(3) Izod Notch Toughness	(4) Resistance to Pounding
19	0.24	0.16	3.4	54
25	0.36	0.14	5.2	22
27	0.32	0.19	4.4	63
29	0.35	0.16	5.6	40
51	0.63	0.25	8.3	81
53	0.62	0.26	8.5	86
55	0.53	0.29	3.9	109
66	0.50	0.19	8.4	20
71	0.64	0.18	12.1	20
72	0.41	0.19	8.6	38

A typical listing and comparison of various popular, cast bronze bearing alloys.

Resistance to Fatigue

This is the ability of the bearing material to withstand shocks and loads without detericration or fracture. It is particularly valuable in testing bearings for internal combustion engines with rapidly alternating stresses on bimetal bearings such as steel backed, babbitt or bronze lined.

Izod Notch Toughness

This determines the amount of energy in foot pounds required to break a specimen. The specimen is notched and the energy required to fracture in a single blow indicates the toughness.

Resistance to Wear

This test determines the physical ability to resist destruction of two surfaces rubbing together without lubrication. The results are usually tabulated in the loss of weight in grams per 10,000 revolutions.

Resistance to Pounding

This is determined by establishing the number of blows of a hammer weighing 7.5 pounds, falling 2 inches, are required to deform the specimen 5%.

Coefficient of Friction

This test in bearing material is always computed on a "dry" basis, or a set up in which no lubricant of any kind is used. It is usually determined on an Amsler wear test machine.

Thermal-Conductivity

Thermal-conductivity is the ability of a bearing or bearing material to dissipate heat. It is a determination of the B.T.U.'s, per unit of time that will move through the material.

•

Engineering Service

Johnson Bronze offers manufacturers of all types of equipment a complete engineering and metallurgical service. We can help you determine the exact type of bearing that will give you the greatest amount of service for the longest period of time. We can show you how to design your bearings so that they can be produced in the most economical manner. As we manufacture all types of Sleeve Bearings, we base all of our recommendations on facts free from prejudice. Why not take full advantage of this free service?

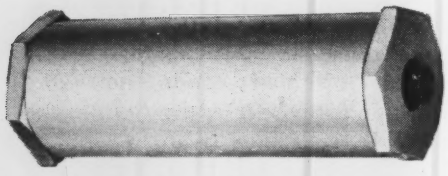
•

This bearing sheet data is but one of a series. You can get the complete set by writing to—

Johnson Bronze

SLEEVE BEARING HEADQUARTERS
525 S. MILL ST. • NEW CASTLE, PENNA.

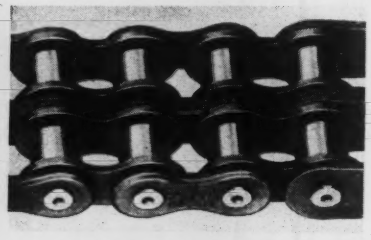
NEW PARTS AND MATERIALS



20 oil. Ports are ⅜-in. National Pipe Thread. Unit measures 5½-in. long by 2$\frac{3}{16}$-in. Manufacturer: Waterman Engineering Co., 721 Custer Ave., Evanston, Ill.

For additional information circle MD 16 on Page 171

Roller Chain Assembly

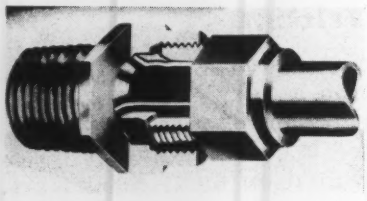


Designed to simplify field maintenance, BA roller chain assembly combines long life and low cost of riveted chain with ease of assembly and disassembly of cottered roller chain. It consists of 5-ft basic length of standard riveted roller chain with single pin connector assembled at approximately 2-ft mark and at end of chain. Connecting link employs one detachable cottered pin and one rivet.

Available for all standard roller chains from 1-in. pitch to larger sizes in both single and multiple types, BA assembly is supplied in basic 5-ft lengths, packed two per box. These basic units plus standard short units—A units, B units, two, six and ten-pitch units—allow building exact length desired without need for cutting riveted chain. Offset links can be employed where chain has elongated through normal wear. Where chains are subjected to unusual stresses and high overloads, BA assembly can be furnished with heat-treated pins. Manufacturer: Chain Belt Co., Baldwin-Duckworth Div., Springfield 2, Mass.

For additional information circle MD 17 on Page 171

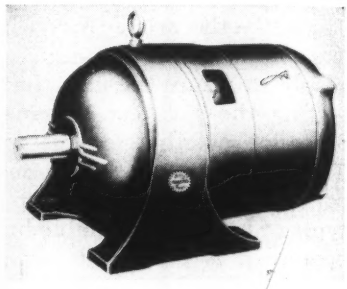
Aluminum Tube Fitting



Positive connections in annealed aluminum tubing are effected by Uniflare two-piece self-flaring aluminum fittings. Body of the fitting contains a flaring cone, and the nut incorporates a thrust collar. One turn of nut with ordinary wrench is sufficient to shear off the collar, and further tightening clamps collar on tube to form leakproof seal. There is no danger of tube cracking during flaring, and fitting can be disassembled or reassembled many times without impairing tightness of seal. Anodized for corrosion resistance, fitting is available in all standard shapes on made-to-order basis for use with tubing $\frac{3}{16}$ to ½-in. OD. Manufacturer: Scovill Mfg. Co., Waterbury 91, Conn.

For additional information circle MD 18 on Page 171

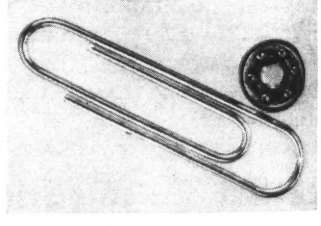
Triple Reduction Gearmotor



Single, double and triple reduction gearmotors are available in 17 sizes from 1 to 75 hp with output speeds from 780 to 7.5 rpm. Wide selection of motor enclosures is offered including open, drip-proof, splashproof, totally enclosed and explosionproof constructions. Alternating and direct-current motors of all types as well as motors having special electrical characteristics are available to meet all installation and application requirements. Helical gears and other moving parts are processed and heat treated to assure good wear life, quietness of operation and compactness. Manufacturer: Foote Bros. Gear & Machine Corp., Chicago 9, Ill. and Louis Allis Co., Milwaukee 7, Wis.

For additional information circle MD 19 on Page 171

Miniature Ball Bearing



Measuring $\frac{3}{32}$-in. wide with ¼-in. OD and $\frac{1}{8}$-in. bore, No. R 1-4 Micro ball bearing is recommended for use in fields of instrumentation and control, especially in widely-used synchro and servo devices. It employes Condrad retainer of pressed and hardened beryllium copper having tensile strength of 180,000 psi. Bearing is fully ground with both outside and bore diameters held to tolerances of plus 0-in., minus 0.0002-in. Manufacturer: New Hampshire Ball Bearings Inc., Peterborough, N. H.

For additional information circle MD 20 on Page 171

Rotary Actuators

Featuring split-field, reversible, explosionproof d-c motor and electromagnetic brake, models 186, 188 and 189 rotary actuators also incorporate planetary gear assembly and circuit switch assembly within small envelope. Actuators are designed to drive mechanisms requiring high torques for few degrees of rotation or several revolutions. Standard gear assemblies

You can make them better with COLD-FINISHED J&L JALCASE

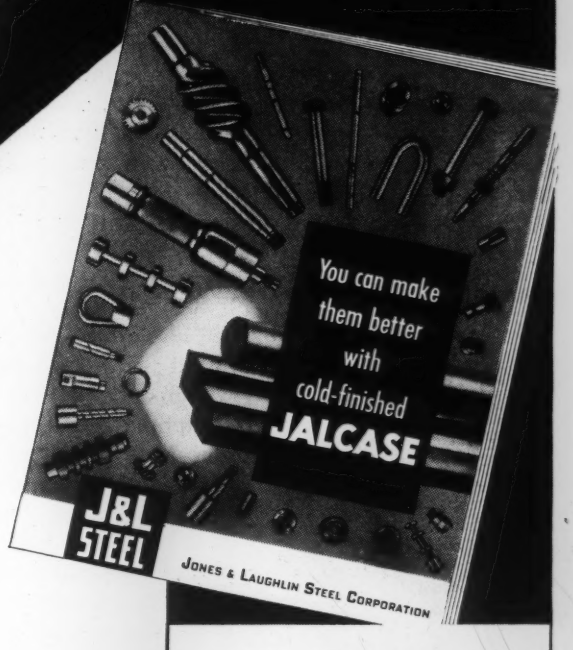
The original
Free Machining Cold-Finished
OPEN HEARTH STEEL

J&L STEEL

IF YOU WANT GOOD

. . . machinability
. . . heat treating properties
. . . high cold-drawn physical properties

SAY J&L JALCASE



★ **Available in a range of grades to suit a wide variety of applications.**

★ **Supplied as cold-drawn or cold-drawn-with-metallurgical-processing, which includes special tempering.**

Typical Jalcase analyses are found in the A.I.S.I. 1100 series. The usual manganese content is 1.00% to 1.65%. J&L, as the originator of these grades, can give you the benefit of years of know-how in the making of steel and the application of Jalcase to your particular requirements.

Some part you are now making can be made *better* from Jalcase with savings in money and time. Write us for a copy of "You Can Make Them Better With Cold-Finished Jalcase."

JALCASE STEEL IS QUALITY CONTROLLED FROM OUR OWN MINES THROUGH THE FINISHED PRODUCT.

Jones & Laughlin Steel Corporation
410 Jones & Laughlin Building
Pittsburgh 30, Pennsylvania

Please send me a copy of your booklet, "You Can Make Them Better With Cold-Finished Jalcase."

NAME_____

COMPANY_____

ADDRESS_____

JONES & LAUGHLIN STEEL CORPORATION

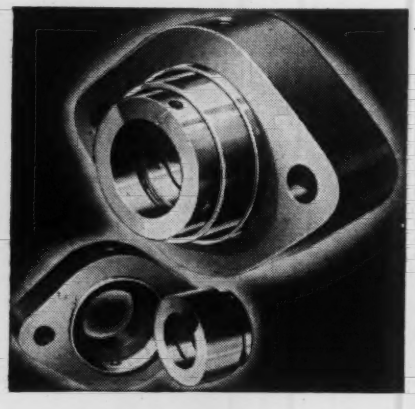
From its own raw materials, J&L manufactures a full line of carbon steel products, as well as certain products in OTISCOLOY *and* JALLOY *(hi-tensile steels).*

PRINCIPAL PRODUCTS: HOT ROLLED AND COLD FINISHED BARS AND SHAPES • STRUCTURAL SHAPES • HOT AND COLD ROLLED STRIP AND SHEETS • TUBULAR, WIRE AND TIN MILL PRODUCTS • "PRECISIONBILT" WIRE ROPE • COAL CHEMICALS

are designed to withstand maximum load of 45 lb-in., and in special designs up to 200 lb-in. without mechanical failure. Units operate freely throughout ambient temperature range of −65 to 160 F. Manufacturer: Lear, Inc., 110 Ionia Ave. N.W., Grand Rapids 2, Mich.

For additional information circle MD 21 on Page 171

High-Pressure Seal



Especially designed to meet sealing requirements of equipment handling hydrocarbons under high pressures and temperatures, improved Fel-Pro type H-P seal is suitable for wide variety of liquids at pressures up to 600 psi and temperatures up to 250 F. Improved control and balance of hydraulic pressures are incorporated to eliminate problem of excessive sealing face wear. Reduction in number of parts susceptible to wear and deterioration minimizes maintenance, and simplified cooling method eliminates need for auxiliary cooling systems. Manufacturer: Felt Products Mfg. Co., Packing Div., 1508 Carroll Ave., Chicago 7, Ill.

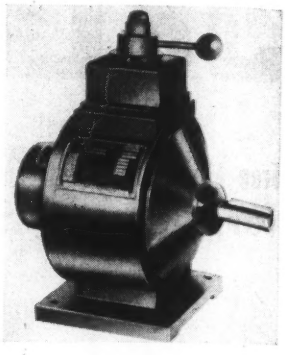
For additional information circle MD 22 on Page 171

Industrial Pneumatic Wheel

Usable on high and low-speed trailers, trucks, wheelbarrows and similar equipment, this pneumatic wheel is water and air-tight and permanently lubricated. Cast in permanent molds, wheel is corrosion-resistant and spark-proof. Double-wall construction transmits load direct to surface of tapered roller antifriction bearings. Neoprene O-rings and formed cadmium-plated steel retainers fitted into hub insure air-tight seal which permits immersion in water without loss of operating efficiency or damage to bearings. Condensation will not occur within hub. Speedy tire changing without tools is accomplished by spring steel lock ring and flange side ring. Manufacturer: Aerol Co., 2820 Ontario St., Burbank, Calif.

For additional information circle MD 23 on Page 171

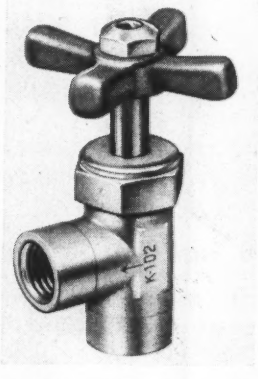
Hydraulic Power Pump



By incorporating manual control, to regulate pump output from 0 to 6 gpm, Junior hydraulic pump can now be used for convenient control of machine operation without variation in driving motor speed. Pump has 6-gpm capacity at 5000 psi and is suitable for pulsation-free feed for production machines in plastics and metalworking fields. Overall dimensions are 11½ x 10 in. including base. Unit can be supplied without base for flange mounting if desired. Manufacturer: Superdraulic Corp., 14256 Wyoming Ave., Detroit 4, Mich.

For additional information circle MD 24 on Page 171

Angle Needle Valve



Affording easy to open and easy to close finger operation, K-102 angle needle valve eliminates stem leakage. Stronger and lighter bodies, forged from aluminum and featuring stainless steel stems which have been ground to form a perfect seat, characterize these precision-made valves. Valve is obtainable with ¼ and ⅜-in. tube connections, and ⅛ and ¼-in. pipe thread connections or any of these in combination. Manufacturer: Kohler Co., Kohler, Wis.

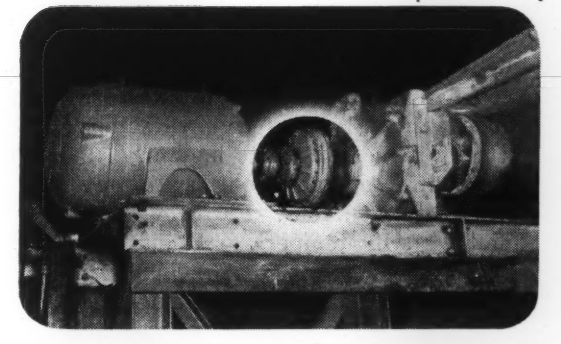
For additional information circle MD 25 on Page 171

Electrical Panel Instruments

Unaffected by shock, severe vibration and tumble testing, Ruggedized line of electrical panel instruments utilizes redesigned basic D'Arsonval type DC movement. Shock mount successfully attenuates high-amplitude low-frequency shock forces, and its low mass reduces magnitude of forces developed by shock. Frame structure secures core against shock failure. Fastening techniques and materials prevent magnet fracture, increase shear resistance and minimize whipping and collision between dial and pointer assembly. High torque-to-weight ratios permit large radius pivots and

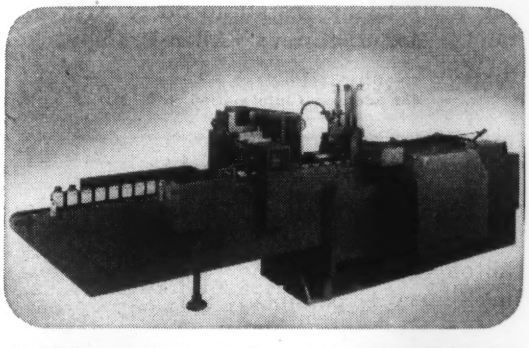
Kid Glove Power for product handling

Are you planning a conveyor or packaging machine that requires extra-smooth, steady power delivery . . . one that can't tolerate a "sticky" clutch with a jerky pace? Then it will pay you to check the following reports of Twin Disc shock-absorbing power links at work.



The Twin Disc Hydraulic Coupling* on this 500-foot coal mine conveyor cushions jolts of intermittent loading, starting and stopping . . . eliminates overmotoring at the start, prevents stalling of motor. *Ask for Bulletin 136.

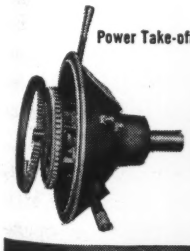
To synchronize the two motors and prevent chain breaks on this pickling bin conveyor, a Twin Disc Hydro-Sheave Drive* was installed on each motor. The result was automatic synchronization of the motors, smoother operation, and a sharp reduction in maintenance costs and down-time. *Write for Bulletin 145-A.

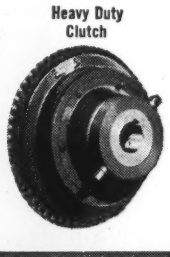


This Redington cartoning machine, continuously on the job since 1944, drives smoothly, quietly and efficiently through a Twin Disc Model MTS Friction Clutch.* Unusually compact, this clutch has exceptionally high torque capacity and is engineered to fit easily into your design. *Request Bulletin 134-A.

Twin Disc engineers, specialists in power transmission, have helped many of the country's leading manufacturers solve their application problems. They will gladly consult with you . . . at no obligation, of course.

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).





TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES
REG. U.S. PAT. OFF.

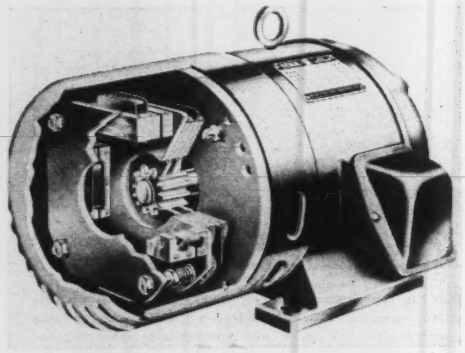
SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

reduce unit loading of bearings. Laminated aluminum alloy tubing pointer utilizes positive lock on balance cross of moving system and permits electrical overloads without pointer damage. Hermetic sealing gives weather protection in any climate, and mounting ring distributes forces set up under high shock. Manufacturer: Marion Electrical Instrument Co., Manchester, N. H.

For additional information circle MD 26 on Page 171

Adjustable Electric Brakemotor

Improvements in this brakemotor contribute to quick braking and easy adjustment of braking load for varied service conditions. Braking disks are mounted close to motor to minimize strain and wear on shaft and bearings. Magnets are located away

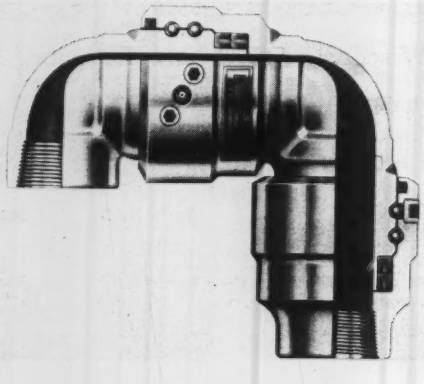


from motor for maximum heat dissipation. Tension springs are situated on main brake studs for easy adjustment when required. Brake cover is readily removable. Manufacturer: Star Electric Motor Co., Bloomfield, N. J.

For additional information circle MD 27 on Page 171

Swivel Pipe Coupling

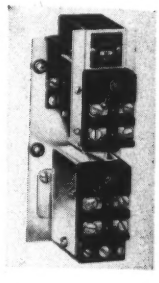
Specifically designed to convey fluids under high pressure, All-Flex ball bearing swivel pipe coupling rotates 360 degrees in all planes. Available in a wide



range of sizes, unit operates at speeds up to 60 rpm, at temperatures up to 225 F and at pressures to 12,000 psi. Rotating members of coupling are held together with two sets of ball bearings operating in flame-hardened and ground races. Metal-backed packer assembly consists of two packers, each comprised of T-shaped metal backer to which a pair of synthetic rubber lips is vulcanized and bonded. Each backer functions in its own individual chamber. Edges of metal backer flare outward against walls of packer recess to form full metallic seal. All high-pressure swivel couplings are steel. Low-pressure couplings are bronze, aluminum, malleable iron or steel. Manufacturer: Gil-Lair Products Inc., 81 Masonic Ct., Pasadena 3, Calif.

For additional information circle MD 28 on Page 171

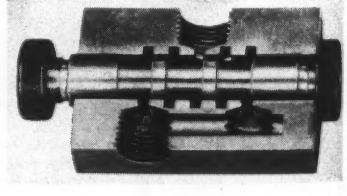
Pneumatic Timing Relay



Accuracy within 10 per cent is obtained by Bulletin 849 pneumatic timing relay which has a range from 10 cycles to 3 minutes. It utilizes synthetic rubber bellows for controlling tripping time and resets instantly. It is available for operation on alternating or direct current. Performance is unaffected by temperature, humidity or vibration. Unit is supplied with quick make-and-break, double-pole, silver alloy contacts, one set normally open and one set normally closed. Terminals are readily accessible from front. Duplicate set of contacts can also be provided, actuated directly from solenoid and opening and closing instantaneously with action of solenoid. Manufacturer: Allen-Bradley Co., Milwaukee 4, Wis.

For additional information circle MD 29 on Page 171

High-Cycling Air Valve



Complete control of automatic and semi-automatic pneumatic machinery is possible with Hi-Cyclic air valve which will stop and return the stroke of the cylinder within 0.001-inch, at any point, control stroke speed in either direction, control pressure in both ends of cylinder and effect savings in air consumption. Spool-type valve uses no packings or seals and has stainless steel piston, valve body being constructed of bronze bar stock. Dual ports equalize pressure on piston and provide balanced operation. Built-in directional speed control operates by adjusting stop nuts located on each end of piston.

Model B basic valve is usable for reciprocating service at speeds to 2500 cycles per minute. It is also available as spring loaded valve for cam operation or motor control and as dual exhaust valve for controlling speed of stroke where piston stop nut ad-

How to Build Levers at Less Cost

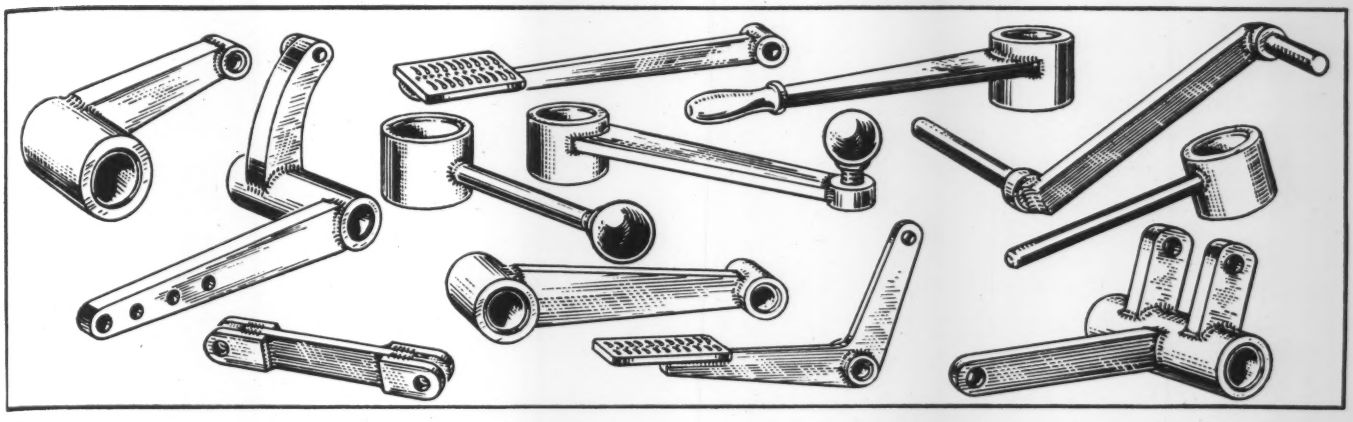


Fig. 1. Typical machinery operating levers that are being weld-fabricated at lower cost with arc welding.

ALL types of levers are being weld-fabricated in shops throughout the country, helping to produce stronger, lighter machinery construction with improved appearance . . . *all at less cost than with other methods.* Here is how these levers are built:

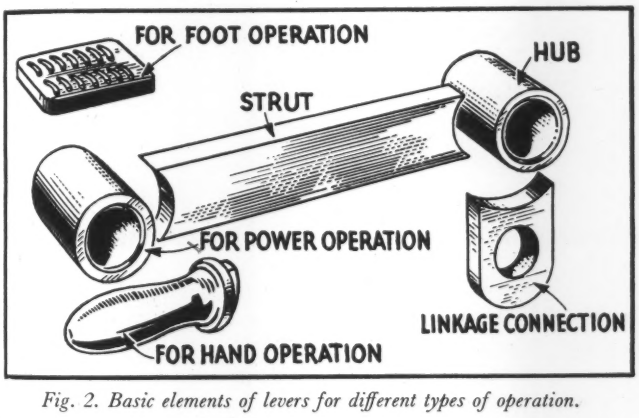


Fig. 2. Basic elements of levers for different types of operation.

More detailed data on the design of levers for arc welding is contained in the "Procedure Handbook of Arc Welding Design and Practice." Price $1.50 postpaid in the U. S. A.; elsewhere $2.00.

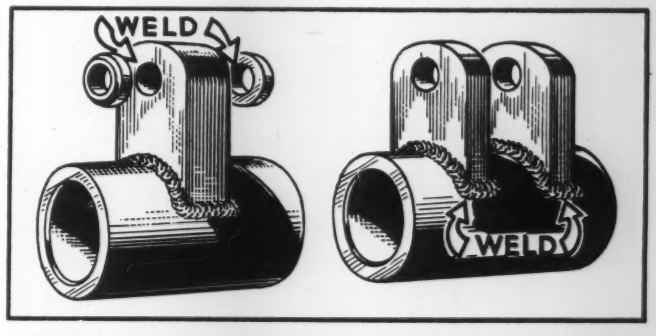


Fig. 3. Linkage connections for power take-off, made from steel straps.

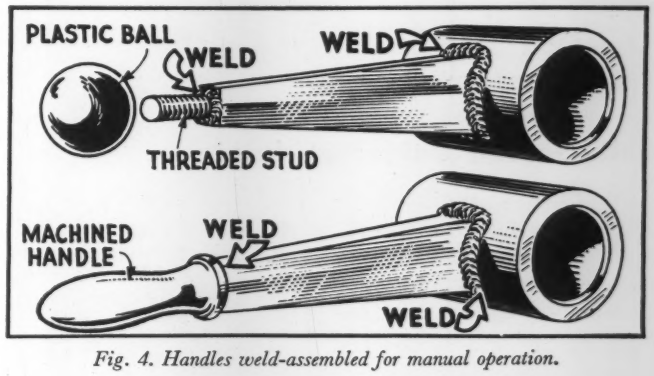


Fig. 4. Handles weld-assembled for manual operation.

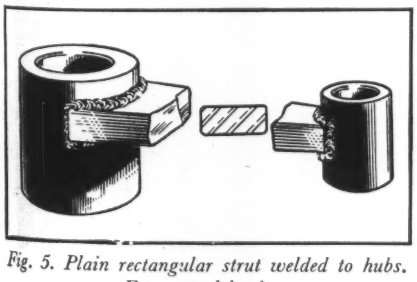


Fig. 5. Plain rectangular strut welded to hubs. For normal loads.

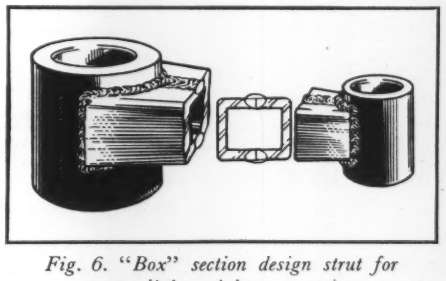


Fig. 6. "Box" section design strut for strong, light-weight construction.

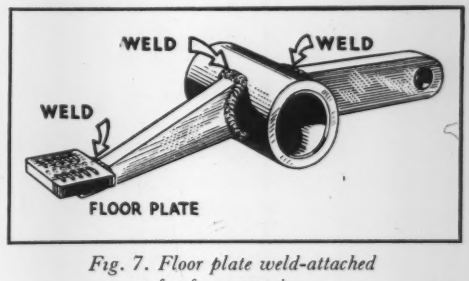


Fig. 7. Floor plate weld-attached for foot operation.

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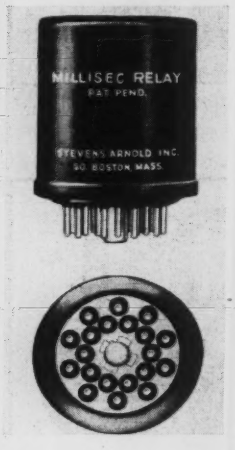
justment is not feasible. Other types include model B-1 single solenoid and model B-2 double solenoid types; piloted valves and four-way hydraulic valves. Models range in size from ⅛ to 1 in. standard U. S. pipe size ports. Manufacturer: Beckett-Harcum Co., Wayne Rd., Wilmington, O.

For additional information circle MD 30 on Page 171

High-Speed D-C Relay



Designed for operation with resistive load, Millisec ultra-high speed relay is rated ½-amp 110-volts d-c on contacts and does not require external spark suppression circuit. Unit is hermetically sealed and has operating time of one millisecond or less. Relay is offered in single and double-pole double-throw construction with 8-pin octal base and with 20-pin octal base in 3, 4, 5 and 6-pole double-throw models. Freedom from bounce is afforded by shock absorbing mechanism. Relay is enclosed in standard 6N7 type metal radio tube container and is wax-sealed. Life expectancy varies from 22 million operations at ½-amp to 100 million operations at ¼-amp. Manufacturer: Stevens-Arnold Inc., 22 Elkins St., S. Boston 27, Mass.

For additional information circle MD 31 on Page 171

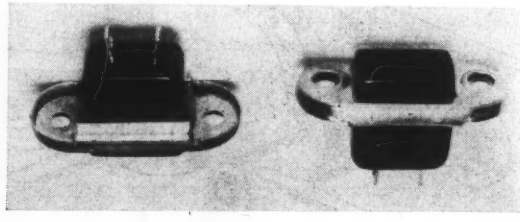
Fully-Sealed Universal Joint

Specifically designed for severe operating conditions, series K2R fully-sealed universal joint is available in complete assemblies or as single joint for farm equipment and industrial and construction machinery. Utilizing one-shot lubrication, the joint employs a cork washer and retainer on each of four trunnion bearings to seal lubrication and to keep dirt and grit out of working parts. Manufacturer: Blood Brothers Machine Co., Allegan, Mich.

For additional information circle MD 32 on Page 171

Miniature Electric Outlet

Approved by Underwriters' Laboratories for 15 amp at 125 v and 10 amp at 250 v, this miniature auxiliary power outlet requires mounting centers of only 1⅛ in. and rear clearance of 1 in. Mounting holes permit quick assembly to panel and double mounting plate affords rigidity. Body is molded black phenolic;

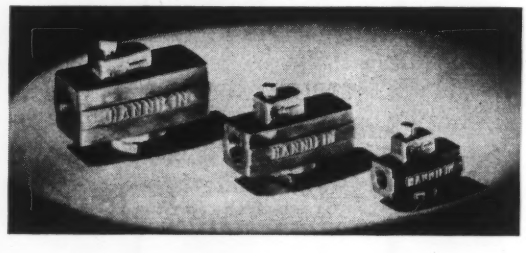


other colors are available. Back of molding is solid so that clip will not push through. Manufacturer: Alden Products Co., 117 N. Main St., Brockton 64, Mass.

For additional information circle MD 33 on Page 171

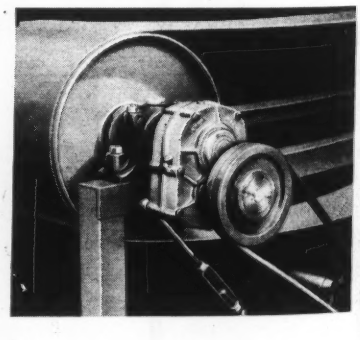
Speed Control Valve

Usable on pressures up to 150 psi, type S speed-control valve for controlling pneumatic cylinders is made in ¼, ⅜, ½ and ¾-in. pipe sizes. Guided poppet of ample diameter allows full pipe-size flow toward cylinder, Metered flow away from cylinder is afforded by threaded valve stem which permits sensitive adjustment from 0 cfm to maximum capacity. O-ring seal warns operator when point of maximum adjustment has been passed. Manufacturer: Hannifin Corp., 1116 S. Kilbourn Ave., Chicago 24, Ill.



For additional information circle MD 34 on Page 171

Torque-Arm Speed Reducer



Consisting of reducer with fixed ratio of 15 to 1, Torque-Arm speed reducer mounts directly on shaft and is driven by motor through flat or V-belt drive. It is available in six sizes to 28.5 hp. Any desired output speed from 13 to 133 rpm can be obtained through use of stock sheaves. Reducer contains double train of heat treated and shaved helical steel gears. It is locked to shaft on both sides of unit by steel collars. Keyed bushing adapts sleeve to any desired shaft size. Torque arm anchors reducer and provides quick easy adjustment of belt tension through use of turnbuckle. Where prevention

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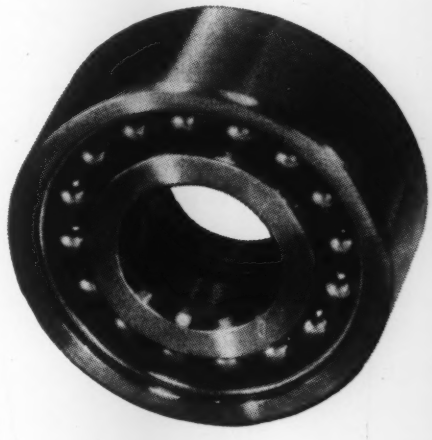


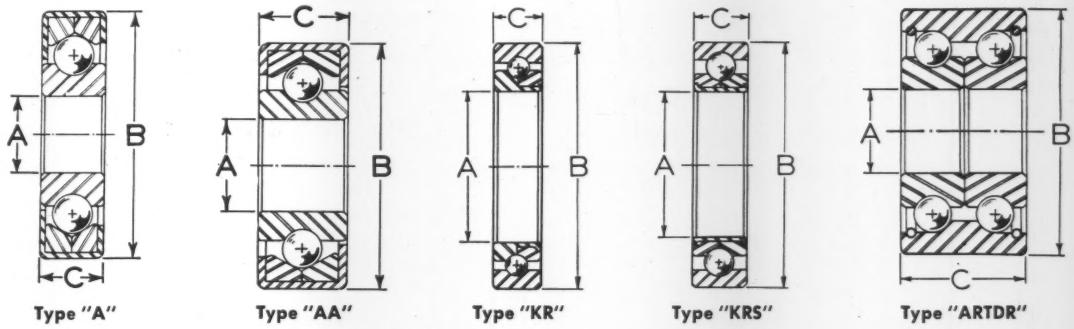
Among the many types of Schatz "Commercial" Ball Bearings now furnished in metric sizes are:

Type "A" *Unground* Ball Bearings

Type "AA" *Precise* Single Row Ball Bearings

Types "KR" and "KRS" Ball Bearing Rollers with Hardened Tread

Type "ARTDR" *Unground* Radial-Thrust Double Row Ball Bearings



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of load reversal is required, backstop is available which is easily installed on input shaft and sealed from dust and dirt inside cast-iron housing. Applications of reducer include driving conveyors, bucket elevators processors, etc. Manufacturer: Dodge Mfg. Corp., Mishawaka, Ind.

For additional information circle MD 35 on Page 171

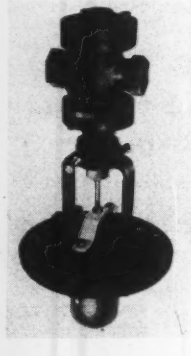
Die-Stamped Nameplates

Product identification, trade marks, brand names and slogans can be die-stamped of metal to individual specifications by this nameplate stamping service. Plates are obtainable in sizes up to 9 x 12 in. and 3/32-in. thick of any metal that can be stamped. They can be delivered on production basis of from 3 to 10,000. Service offered by Federal Tool & Mfg. Co., 3620 Alabama Ave., Minneapolis 16, Minn.

For additional information circle MD 36 on Page 171

Air-Operated Control Valve

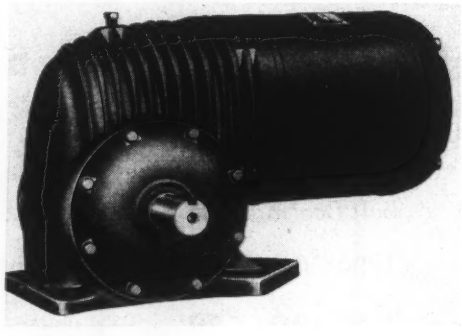
In few minutes' time and without use of special tools, Stabilflo air-operated control valve can be changed from air-to-open to air-to-close without removing it from line or shutting down controlled flow. To reverse action of valve motor it is necessary only to remove housing assembly, rotate it one-quarter turn and replace it. This valve is recommended for use where changes must be made in existing installations, for pilot plant operation and for simplification in stock of spare valves which are ordinarily kept in reserve. Manufacturer: Foxboro Co., Foxboro, Mass.



For additional information circle MD 37 on Page 171

Worm Type Gearmotor

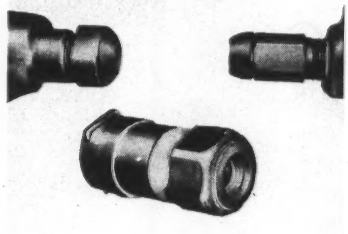
Extending range of line from 1/8 to 1½ hp, this worm type 1½-hp gearmotor is obtainable for operations on single or polyphase alternating or direct current. Speeds from 25 to 280 rpm can be attained. Armature and output shafts are only moving parts. Only four bearings, two ball and two roller, are employed. Larger ratings to 400 hp with gear attachments are available. Manufacturer: Century Electric Co., Gear Motor Div., 1806 Pine St., St. Louis 3, Mo.



For additional information circle MD 38 on Page 171

Cartridge Type Revolving Joint

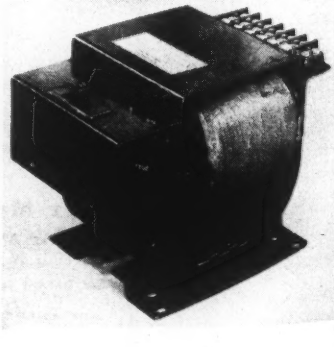
This cartridge type revolving joint is suitable for conducting fluid to all types of rotating rolls. Rotation takes place between ball and seal that will withstand temperatures from −40 to 500 F. Another ball screws into piping, and cartridge assumes position between two balls to minimize roll misalignment. Spring-seated seal inside cartridge is pressure-tightened. Joint has low turning torque, requires no lubrication, and needs no flexible hose for mounting. Usable with steam, air, oil, gas, water and other fluids, joint is supplied in ½, ¾ and 1-in. pipe sizes. Manufacturer: Rotherm Engineering Co., 4911 W. Irving Park Rd., Chicago 24, Ill.

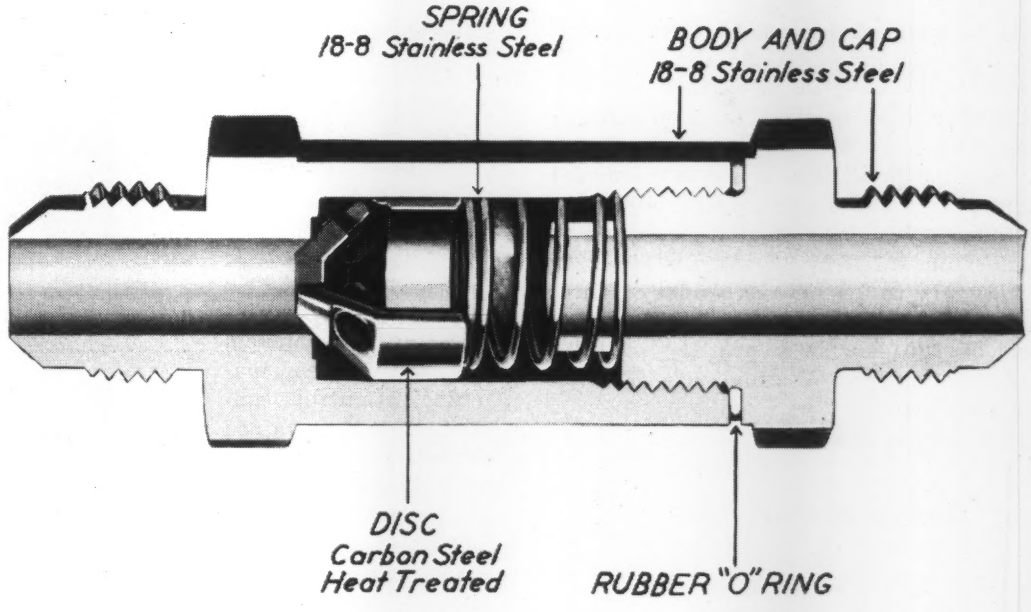


For additional information circle MD 39 on Page 171

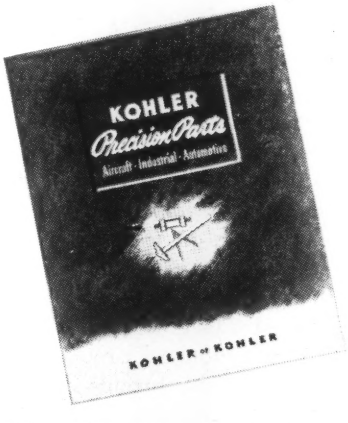
Standardized Control Transformer

These standardized transformers are particularly adapted for inductive, low power factor loads of solenoids, relays and contactors. Secondary voltage remains above 90 per cent of rated voltage up to load current of seven times normal at 20 per cent load power factor. Transformers larger than ½-kva are small in size and





Specify KOHLER precision made CHECK VALVES for long service



Kohler Cone Type Check Valve, K-1249, is a high pressure valve increasingly specified for hydraulic fluids, gasolines, oils, water and acids non-corrosive to stainless steel. It has an operating pressure up to 3000 PSI, and a burst pressure of 7500 PSI. The metal-to-metal seat in this valve is best suited for high pressures, extreme temperatures and corrosive fluids. Available in sizes ¼", 5/16", ⅜", ½" and ⅝". Larger sizes and combinations of connections can be furnished to your requirements.

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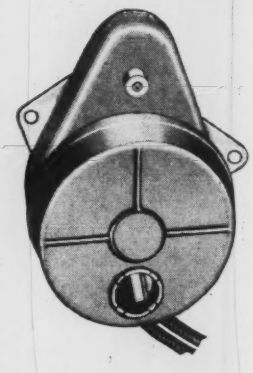
light in weight because of use of type C Hipersil cores of grain-oriented magnetic steel. Circuit breaker protection is normally supplied on ratings of 0.300-kva and larger, while fuse block is used on sizes of 0.150-kva and smaller.

Seven sizes from 0.075 to 1.5 kva are available for 220/440-v primary to 110-v secondary at 60 cycles. Transformers for 50-cycle operation are supplied in six sizes ranging from 0.150 to 1.5 kva for 208/220/380/416/440-v primary to 110/95-v secondary. Three sizes from 0.150 to 0.500-kva are available for 25-cycle operation at 220/440/550-v primary to 110-v secondary. Manufacturer: Westinghouse Electric Corp., Pittsburgh 30, Pa.

For additional information circle MD 40 on Page 171

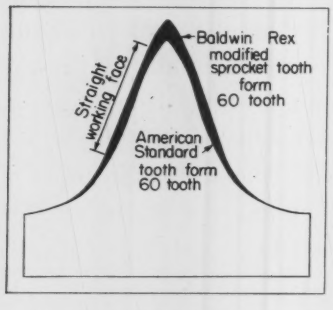
Synchronous Timing Motor



Series of self-starting synchronous timing motors with shaft speeds from 1/60 to 1 rpm is applicable for use with many time controlled products such as time switches, range timers, interval timers, coin meters, flow meters, electric clocks, electric counters, traffic control signals and photographic timers. High-temperature Glyptol is used to seal gear case to eliminate possibility of corrosion of parts and contamination of oil. Hardened stainless steel rotor shaft insures smooth operation, and noise is minimized by use of spoked aluminum rotor and nylon for first high speed reduction gear. Motors will continue to run at constant speed from 25 per cent below to 25 per cent above rated input voltage and have high output torque with respect to input wattage. Manufacturer: International Register Co., Chicago 12, Ill.

For additional information circle MD 41 on Page 171

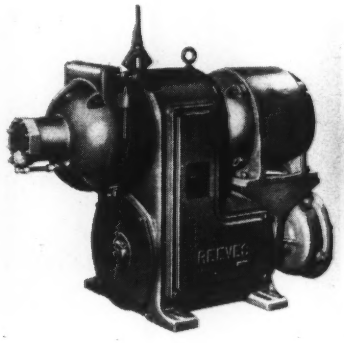
Roller Chain Sprocket



Improved tooth form of this roller chain sprocket is composed of root circle, straight working faces tangent to root circle and topping curves which bring tooth to a point. Gap angle of tooth distributes load over all teeth in mesh. Pressure angle is variable but does not change with chain wear. Longer tooth form accommodates high pitch elongation; straight face permits accurate cutting. Manufacturer: Chain Belt Co., Milwaukee, Wis.

For additional information circle MD 42 on Page 171

Variable Speed Drive Control



Automatic speed changing of Motodrive variable-speed drive is obtained with this hydraulic control. Actuating force is secured by connecting control valve lever to any speed indicating mechanism on the driven machine. Control consists of self-contained hydraulic power plant and simple rotary valve, piston and cylinder in streamlined case. It is mounted on Motodrive in place of customary handwheel. Unit is self neutralizing; oil in circuit acts as brake to prevent movement of oil when control is in neutral position. Once speed setting has been made, unit will hold this exact speed until automatically or manually changed.

Same control without hydraulic power plant is available for pneumatic operation. In this application, compressed air from any available source is connected directly to rotary valve. Compressed air takes place of oil pressure as activating medium. Both hydraulic and pneumatic automatic controls are available on Nos. 4000 to 7000 Motodrives. Manufacturer: Reeves Pulley Co., Columbus, Ind.

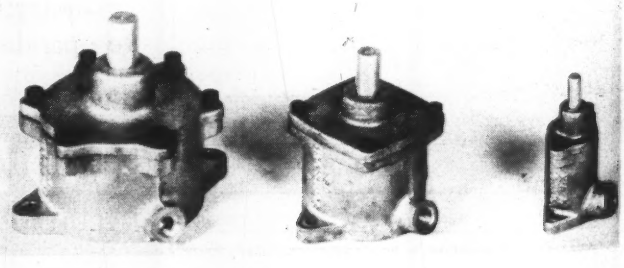
For additional information circle MD 43 on Page 171

Air Cylinders and Valves

These bantam size, compact, push type spring-return air-clamping cylinders are available with 1 and 2-in. stroke lengths and bore sizes of 1, 2¼ and 3 in. Two styles permit easy installation in vertical or horizontal mounting position. They have cast-brass body and are adaptable to a variety of industrial applications.

Also available is a three-way valve with air capacity of 10 cfm at 100 psi. Overall size is only 2⅛ x 1⅝ x 1-3/16 in. Valve houses precision-lapped stainless steel disk which slides on bronze ring to provide positive sealing action. Manufacturer: Scovill Mfg. Co., A. Schrader's Son Div., 470 Vanderbilt Ave., Brooklyn 17, N. Y.

For additional information circle MD 44 on Page 171



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In Federals, maximum unit pressure per ball is not appreciably increased by the addition of thrust loads up to 50% of the rated radial load. Thrust load is distributed over all the balls in the bearing, while radial load is carried by less than half the balls. For pure thrust the rating is 100% of the radial rating.

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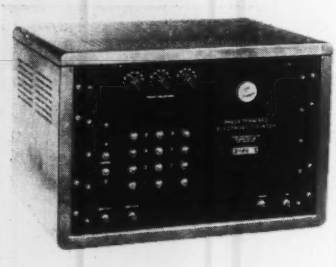
For additional information on these new developments see Page 171

Predetermined Electronic Counter

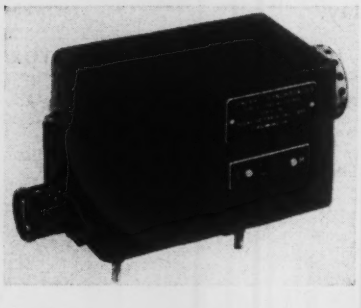


Model 133 Three-Decade electronic counter will predetermine any count from 1 to 999 continuously and provide a high-speed relay action each time the selected count is reached. Other models having capacities of 2 to 6 digits are available. Previous models required a complementary setting of the number; now the predetermined count is selected directly by means of dial switches located on the front panel. The output consists of a high-speed mercury type relay which operates in 2 milliseconds. Several types of relay actions are available. One type, which is ideal for the control of push-pull solenoid deflector mechanisms, consists of a single-pole double throw action that reverses each time the selected count is reached. Another provides adjustable momentary contact closure at the predetermened count. The time of closure can be adjusted over a period of 0.1 to 0.01-second.

Since the counters are completely electronic and contain no moving parts to wear, maintenance is substantially eliminated. Each tube in the counting circuit has associated with it a small neon glow lamp which, in addition to indicating the progression of count, makes possible the rapid detection of defective tubes. Manufacturer: Potter Instrument Co. Inc., 136-56 Roosevelt Ave., Flushing, N. Y.

For additional information circle MD 45 on Page 171

Synchronous Camera



Photographing events at several remote stations with exact shutter synchronization is possible with Model III synchronous camera. It is usable for such industrial applications as oscilloscope photography and studies of machines in motion and automatic control systems. Supplied with shutter speeds of 5, 10 and 20 or 4, 8, 16 and 32 frames per second, camera can be used with standard AN-A-6 or Syno-Pack magazines. Provision is made for single exposure operation, and shutter synchronization is accurate to 1 millisecond. External synchronization pulse circuit is provided. Timing and coding lights mark film to facilitate location of any given sequence or any marked frame without counting. Any number of cameras can be used in parallel gang. Accurately located fiducial marks facilitate boresighting and provide means of obtaining positional data from film frame. Manufacturer: Flight Research Engineering Corp., Richmond, Va.

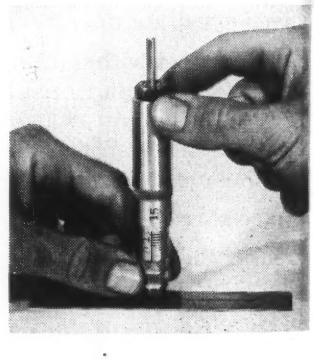
For additional information circle MD 46 on Page 171

Electrosensitive Recording Paper

Usable with helix type or stylus recorders, this low voltage current-sensitive paper records directly and permanently without inertia at speeds to 300 in. per second and up. Multitrace, optically rectified computer and impulse or instrument records can be be made from infrared, radar, facsimile, optical or any scanning head unit. Papers of various sensitivities are available in any width or length for recording black or sepia brown traces on white background. Manufacturer: Alfax Paper & Engineering Co., 40 Riverside Ave., Brockton, Mass.

For additional information circle MD 47 on Page 171

Coating Thickness Gage



Thickness of plating, paint or enamel is determined by Magnifying Micrometer instrument which measures force necessary to overcome magnetic attraction between permanent magnet in instrument and magnetic base material, magnetic coating or their combination. Turning micrometer thimble changes tension on precision spring. When this tension is larger than force holding magnet to surface being tested, magnet will suddenly separate from that surface, moving indicator rod extending above top of tool. This provides definite end point indication. Graduation marks on barrel and thimble are similar to machinist's micrometer caliper markings but are spaced farther apart for easier reading. Except where very small magnetic attraction is present, tool can be used on sloping, vertical or overhead surfaces if kept at about same inclination as surface being measured. Manufacturer: Krouse Testing Machine Co., 573 E. Eleventh Ave., Columbus 3, O.

For additional information circle MD 48 on Page 171

The KAYDON *technique of deep-flame-hardening for bearings of unusual shapes, sizes and thin sections*

Designers and users of special machinery will appreciate this information on **KAYDON**-pioneered deep-flame-hardening which has helped remove bearing-limitations that heretofore proved to be serious handicaps.

This new **KAYDON** technique in deep-flame-hardening hardens only the raceways of the bearings. This permits the races themselves to be accurately drilled, tapped and gear-cut . . . eliminates many of the surrounding parts which normally would be necessary . . . results in important weight-reduction . . . makes possible the creation of unusual designs that accommodate minimum sizes of bearings in the space available . . . permits unusual shapes, very large diameters, and extremely thin sections, all of which greatly facilitate mounting.

Write for this Bulletin on **KAYDON** Deep-Flame-Hardening . . . and when you need the unique services offered, contact **KAYDON** of Muskegon.

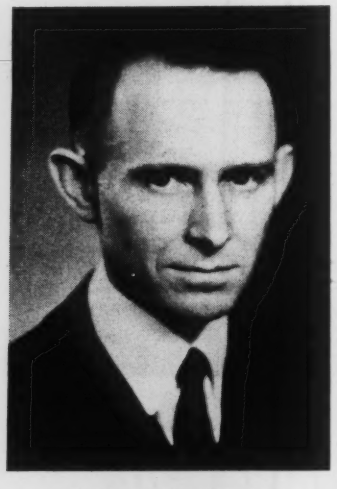
KAYDON Types of Standard or Special Bearings: Spherical Roller • Taper Roller • Ball Radial • Ball Thrust • Roller Radial • Roller Thrust

THE KAYDON ENGINEERING CORP., MUSKEGON, MICH.

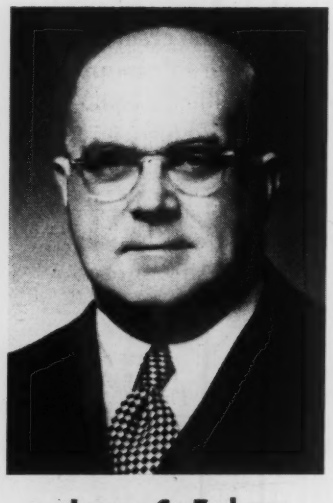
• ALL TYPES OF BALL AND ROLLER BEARINGS 4" BORE TO 120" OUTSIDE DIAMETER •

MEN OF MACHINES

The Richards Memorial Award for "outstanding achievement in mechanical engineering within 20 to 25 years after graduation" was presented to **Arthur M. Wahl,** advisory engineer, Westinghouse Research Laboratories, East Pittsburgh, Pa. at the recent A.S.M.E. annual meeting in New York. Graduated from Iowa State College in 1925 in mechanical engineering, Dr. Wahl went to Westinghouse Electric Corp. as a graduate student and since 1926 has been at the Research Laboratories specializing in mechanical engineering and applied mechanics problems, particularly in the field of stress analysis of machine parts. The A.S.M.E. Junior Award was given him in 1929. Membership in technical and honorary societies include Tau Beta Pi, Phi Kappa Phi, A.S.M.E., A.A.A.S. and S.E.S.A. A foremost authority on springs, Dr. Wahl has been a frequent contributor to MACHINE DESIGN, and is author of *Mechanical Springs* published in 1944 as one of the MACHINE DESIGN series of books.

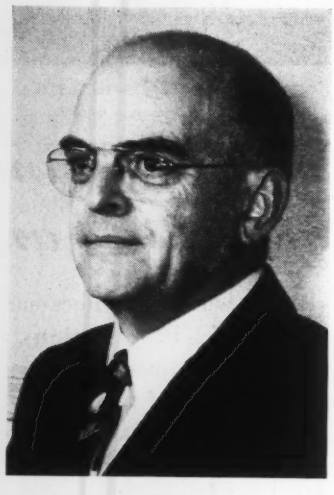


Arthur M. Wahl



James C. Zeder

John Frank Hattersley, vice president in charge of production since 1945, has been promoted to executive vice president of The Hoover Company, North Canton, Ohio. Mr. Hattersley, with the company 29 years, will share with Mr. F. G. Hoover direct supervision of all the company's operations, including the manufacture and sale of its world-renowned electric cleaners, as well as electric irons and fractional horsepower motors. Joining the company in 1920 as chief draftsman, he became assistant chief engineer in 1922 and in 1927 was moved up to the post of executive engineer. In 1933 he moved into the administrative division as an executive assistant and was promoted to assistant vice president in 1937, becoming vice president in charge of production in 1945.



John Hattersley

James C. Zeder, chairman of the engineering board of Chrysler Corp., Detroit, has been elected president of the Society of Automotive Engineers for 1950. Having previously been chief engineer of all Chrysler laboratories since 1933, Mr. Zeder rose to his present position when its engineering board was first formed in 1946. A graduate of the University of Michigan he holds an honorary master's degree from Lawrence Institute of Technology and an honorary doctor's degree from the University of Dayton. Vice presidents elected at the same time are: **Raymond D. Kelly,** United Air Lines; **Harold D. Hoekstra,** Civil Aeronautics Administration; **Wright A. Perkins,** Pratt & Whitney Aircraft; **Rex A. Terry,** Chrysler Corp.; **Albert H. Fox,** Standard Oil Co. of Indiana; **Roy W. Roush,** Timken-Detroit Axle Co.; **Arthur O. Willey,** Lubrizol Corp., **Edward N. Cole,** Cadillac Motor Car Division, GMC;

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FOR QUALITY MOTORS

FLEXIBLE SUPPLY

THERE IS A DELCO MOTOR FOR:

Refrigerators
Washing machines
Dryers
Furnace blowers
Oil burners
Stokers
Water pumps
Gasoline pumps
Compressors
Home work shops
Fans (ventilating)
Dishwashers
Ironers
Office machines
Food grinders
Separators

Appliances need good motors to give dependable service. Years of engineering and manufacturing experience have put top quality into Delco appliance motors.

But today, appliance manufacturers need even more than that. Fast changing markets often mean changes in motor specifications or delivery dates. Because Delco is organized to meet these requirements, manufacturers get what they want—when they want it—changes included.

That's why more and more spec sheets carry the note, "DELCO PREFERRED." Compact Delco Motors, designed to meet the specific torque and service requirements of the application, are built in sizes from 1/8 H.P. up.

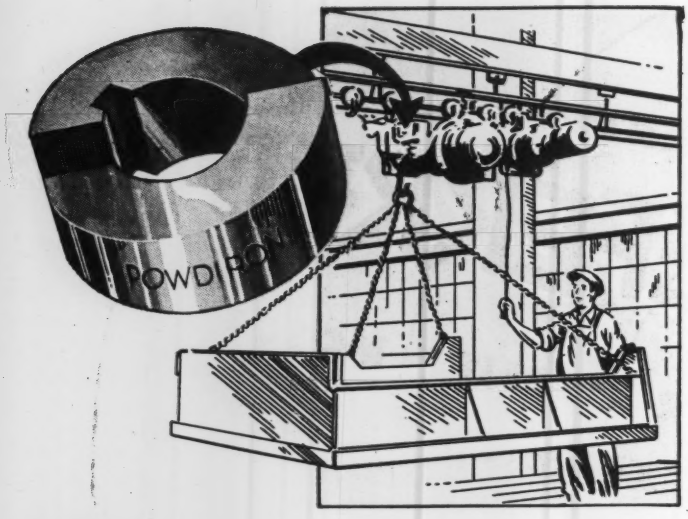
✓ ✓ ✓

Why not get all the facts about Delco Motors? Contact the nearest office listed below—

DELCO MOTORS

Division of General Motors Corporation

SALES OFFICES: CHICAGO • CINCINNATI • CLEVELAND • DETROIT • HARTFORD



*NAME ON REQUEST.

Why a Prominent Industrial Equipment Manufacturer* *Switched to* "POWDIRON" For a CRITICAL CHAIN HOIST PART

Adopting this hoist brake cam, produced by Bound Brook from "POWDIRON" (Sintered Iron) to accurate finished dimensions, ready for assembly, has meant:

- *Elimination of costly, time-consuming machining operations—"POWDIRON" assures an accurate fit.*
- *Continuous lubrication on cam surfaces.*
- *Full required strength for long-time service on tough jobs.*
- *Smooth, sure, safe operation.*

"POWDIRON" has proved to be the perfect material for many heavy-duty bearings, and structural parts such as gears, cams, sockets, pole pieces, levers, etc. Made of pure metal powders, "POWDIRON" parts and bearings are die-formed to accurate dimensions and sintered at high temperatures. Simple or intricate shapes can be produced in quantity to close tolerances. When needed, "POWDIRON" parts and bearings can be vacuum-impregnated with lubricant to give thousands of trouble-free operating hours, without further need of lubrication.

"POWDIRON" SINTERED IRON BEARINGS AND STRUCTURAL PARTS

Consult our engineers on your requirements for structural parts and bearings. *We've saved time and costs for others; we can do the same for you.*

Structural parts are made to your specifications. Bearings in thousands of sizes can be quickly made from dies on hand. Mail coupon below for free copy of our "Powdiron" Data Sheet.

BOUND BROOK OIL-LESS BEARING COMPANY

BEARINGS • BUSHINGS "COPY" "POWDIRON" BOUND BROOK **WASHERS • PARTS**

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Bound Brook Oil-Less Bearing Co.
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Company _____

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Robert F. Steeneck, Fafnir Bearing Co.; **Wayne H. Worthington,** John Deere Waterloo Tractor Works; **Matt E. Nuttila,** Cities Service Oil Co.; and **William P. Michell,** Spicer Mfg., Div. of Dana Corp. The new councilors are: **William E. Conway,** Studebaker Corp.; **Philip J. Kent,** Chrysler Corp.; and **Dale Roeder,** Ford Motor Co.

♦

Cummins Business Machines Corp., Chicago, announces the election of **Otto Doerner** as vice president in charge of manufacturing and engineering. In this new capacity Mr. Doerner will be responsible for the production and engineering activities of the portable tool division as well as those of the business machines division. Prior to joining Cummins more than two years ago as plant manager, he was associated with National Cash Register, Zenith Radio and International Register.

♦

Earl W. Pughe has joined the Wheland Co., Chattanooga, Tenn., as manager of the manufacturing division. This division includes the design and production of Wheland oil field drilling equipment and sawmill machinery. He was formerly assistant to the president of Dana Corp., Toledo.

♦

Advancement of **Don J. Peeps,** chief engineer, to vice president in charge of engineering, DeVilbiss Co., Toledo, has been announced. Entering the company's employ in 1928 as a factory worker, he became chief engineer in 1944. At the same time **William A. Delger,** former plant manager, became vice president in charge of manufacturing.

♦

John H. Swift is now a transmission engineer in the advanced engineering department, Truck Division, International Harvester Corp., Fort Wayne, Ind. He was formerly supervisor of the Torque Converter Unit, Ford Motor Co.

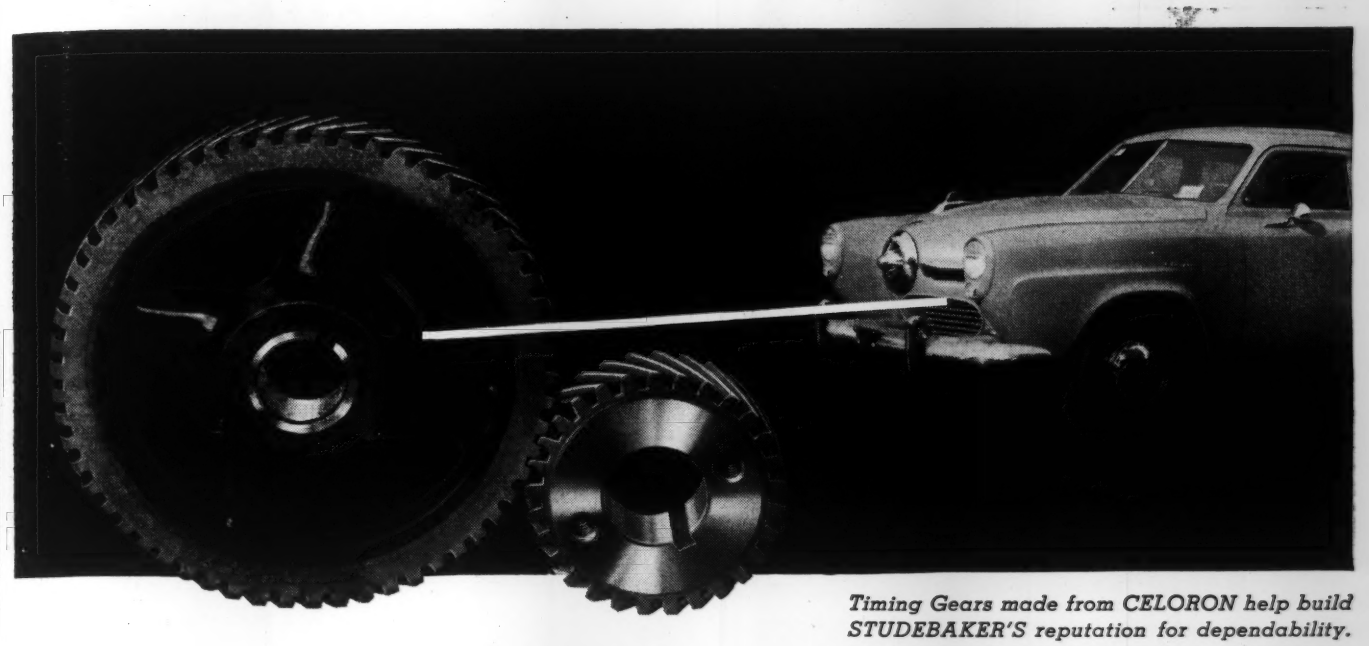
♦

David C. Peterson has been named director of engineering and manufacturing of Division One of Stewart-Warner Corp., Chicago, succeeding **George Thomas,** plant manager since 1943. Prior to joining Stewart-Warner Mr. Peterson was an engineering consultant to diesel engine manufacturers. He was with Continental Can Co. in charge of engineering operations in the tin plate mills. From 1914 to 1934 he was with the Buda Co. rising through various engineering and manufacturing positions to become assistant to the vice president in charge of manufacturing. Mr. Thomas has been appointed production consultant to the senior vice president.

♦

Announcement has been made of the appointment of **Lawrence B. Richardson** as director of research of Fairchild Engine and Airplane Corp., Hagerstown, Md. He was formerly with the Bureau of Aeronautics.

CELORON
. . . what's in it for you and your products?



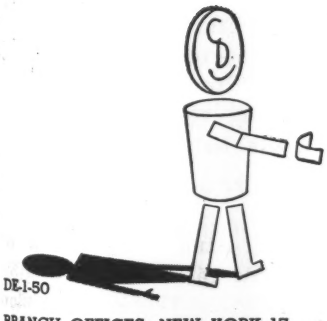
Timing Gears made from CELORON help build STUDEBAKER'S reputation for dependability.

What's in CELORON for you . . . and your products? This different thermo-setting plastic maintains strength and resiliency at temperatures up to 290°F. Resists oil, water and many corrosive chemicals. It is 1/6 the weight of steel—only 1/2 the weight of aluminum! Remarkably easy to machine, Continental-Diamond's CELORON gives you an unusual combination of light weight, high strength, and wear resistance *plus* electrical insulating properties.

CELORON is another example why it pays to see C-D first in your search for the right plastic. For plastics that provide *practical* combinations of mechanical and electrical properties, call your nearest C-D office. Trained technicians on hand at all times to help with your material selection problems.

CELORON—ideal for many mechanical and electrical applications

Specific Gravity	1.35	Impact Strength (Izod) (per inch of notch)	2.3 Ft. Lbs.
Tensile Strength	6,500 psi	Brinell Hardness—500 kg. load (10 mm diameter ball—30 seconds)	38
Flexural Strength	10,000 psi		
Compression Strength	25,000 psi		
Shearing Strength	8,500 psi	Rockwell Hardness	M105



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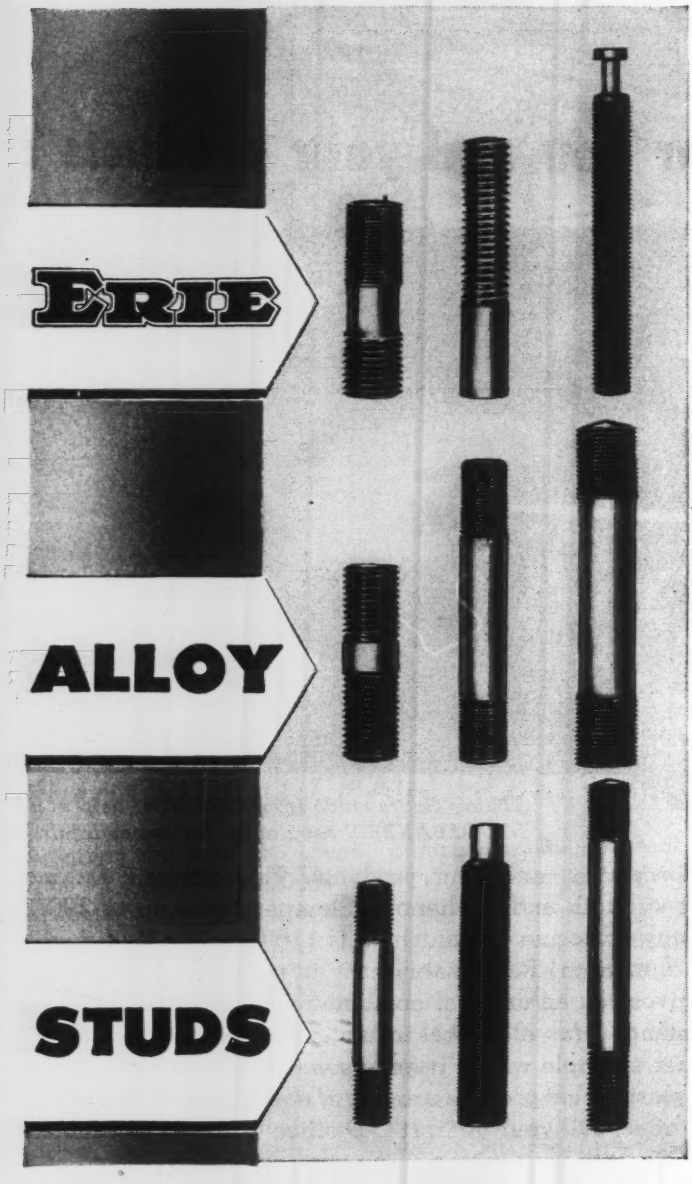

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NEWS OF MANUFACTURERS

Because of its expansion of home appliance and contract manufacturing activities, **General Mills Inc.**, Minneapolis, Minn., has sold its Tray-Lock and finished edge carton set-up machine and ice cream cartoning unit to the **Package Machinery Co.**, Springfield, Mass., manufacturer of wrapping machines.

•

Stevens Manufacturing Co., manufacturer of precision bimetal thermostats for use in appliances, industrial and electronic equipment, has transferred operations to a new plant. The enlarged quarters and facilities are located at 69 South Walnut St., Mansfield, O.

•

To expand its activities in the chemical field, **United States Rubber Co.** has purchased the **Chemicals Division of The Glenn L. Martin Co.** The rubber company will acquire all assets of the division, including the Marvinol vinyl resin plant at Painesville, O., laboratory equipment in Baltimore, and the patents and trade name Marvinol.

•

Since its acquisition by **The Cleveland Graphite Bronze Co., Harris Products Co.**, manufacturer of Silentbloc, Torflex bushings and Harris shackles, has developed its expansion program. Harris' Cleveland operations have been transferred from the Cowan Road plant to substantially larger quarters at 1929 East 61st Street, Cleveland, O., in a building owned by Graphite Bronze. Harris' rubber molding plant, at Milan, O., has been enlarged.

•

The entire manufacturing facilities of **Larkin Lectro Products Corp.** have been moved to a new 75,000-sq ft plant, in Pine Bluff, Ark. Production of Larkin transformers, resistance welding equipment and arc welders has been resumed.

•

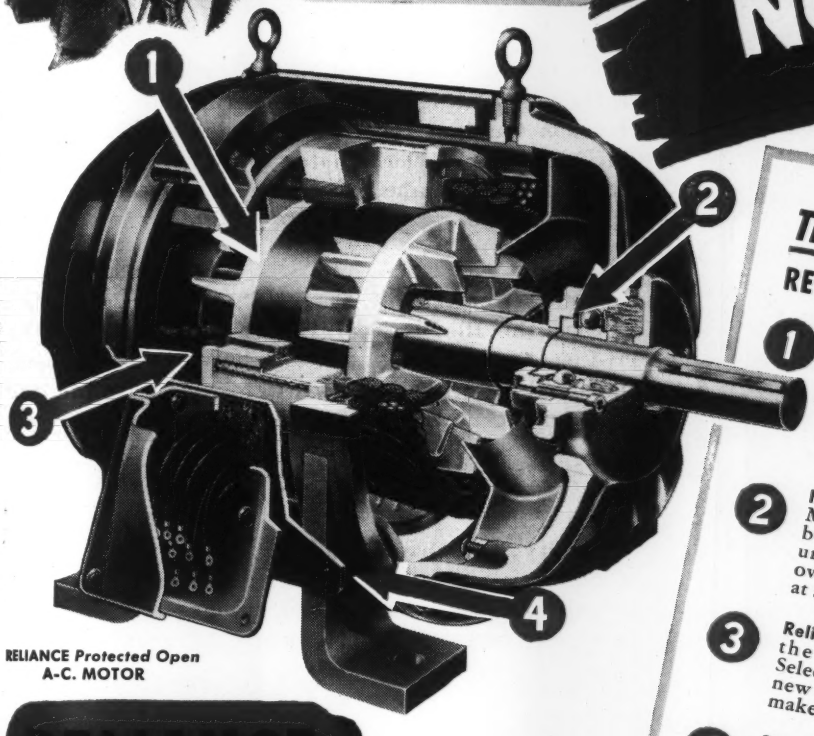
Establishment of the **Nelson Stud Welding Co. of Canada Ltd.**, with manufacturing facilities in Toronto, has been announced by **Nelson Stud Welding Division of Morton Gregory Corp.**, Lorain, O., and its recently appointed Canadian distributor, the Rudel Machinery Co. Ltd.

•

Trabon Engineering Corp., 1814 East 40th St., Cleveland, O., manufacturer of automatic grease and lubricating systems, has licensed a firm in England to pro-

WHY HASN'T SOMEBODY TOLD ME THIS BEFORE?

"...all motors are NOT ALIKE"



RELIANCE *Protected Open* A-C. MOTOR

These 4 Advantages Alone make RELIANCE the motor that is different!

1. **Dynamic Balancing—Precision Fits**—Every motor is dynamically balanced by skilled technicians using latest electronic-principle equipment. Machining of parts to exacting tolerances guarantees precision fits throughout. Result: a smoother-running, longer-lasting motor!
2. **No Lubrication Worries**—Precision Bearing Mounting, with double-shielded ball bearings, assures longer bearing life under all normal conditions, whether overgreased, undergreased or not greased at all. "*You can't grease 'em wrong!*"
3. **Reli-X Insulation** furnishes a new high in the protection of stator windings. Selected materials, exclusive methods and new continuous-sequence applications make this the *unfailing* insulation!
4. **Steel for Strength**—Steel construction, with electrically welded joints, combines maximum strength with minimum weight.

RELIANCE *Precision-Built* MOTORS

...are made ***better*** to deliver DEPENDABLE POWER—LONGER!

Reliance has a way of building motors that must be seen to be fully appreciated. Any time we can take a motor user through the modern plants where Reliance *Precision-Built* Motors are made, we can be reasonably sure of another good Reliance customer. We would be delighted to have you make this visit. But if it isn't practical, call in your nearest Reliance representative and *see* the convincing facts he can show you on the precision methods that produce these truly superior motors. Now available from ¾ to 300 horsepower.

HOW TO SELECT THE RIGHT MOTOR

Here's a book which digests all the information you should have in selecting the motor that's just right for any job. New torque and current standards recently adopted by the National Electrical Manufacturers Association for A-c. motors are tabulated and explained. And these are further supplemented by more detailed performance data on Reliance *Precision-Built* Motors. Write today for this important new Motor Data Bulletin, B-2101.

Sales Representatives in Principal Cities

RELIANCE ELECTRIC AND ENGINEERING CO.

"Motor-Drive is More Than Power" • 1079 Ivanhoe Road, Cleveland 10, Ohio

ACTUAL SIZE

OF A 3" BORE HYDRAULIC CYLINDER

NEW O-M CYLINDER

SAVE 1/3 IN SPACE

A 3 inch bore Ortman-Miller cylinder measures just 3¼" in outside diameter. No tie-rods, no bolts. That means, bore for bore, the O-M cylinder needs a third less space than conventional units.

All body parts are machined steel (not cast). All bearing surfaces bronze. Circumferential keys allow disassembly and repacking in a matter of minutes . . . or mountings may be changed without disassembly. No ball check needed. Ports adjustable to any angle. Continuous duty to 1,500 cycles per minute guaranteed. All parts and mounting brackets are interchangeable.

Ortman-Miller air, hydraulic and water cylinders are immediately available in a full range of sizes from 1½ to 8". Write today for full details and specifications. See for yourself how this space-saving advantage can be applied to your own equipment.

ORTMAN-MILLER
MACHINE CO., INC.
1210 150th Street, Hammond, Ind.

duce Trabon equipment. The British company is **Exactor Control Co. Ltd.,** 108 Park St., London, which has organized a division to be known as **Exactor-Trabon.**

♦

A new $9,000,000 hot-rolled strip mill, located in Conshohocken, Pa., has been placed in operation by the **Alan Wood Steel Co.** The plant has an estimated finished steel capacity of 218,000 tons annually.

♦

Purchase of the controlling interest in **Reed Metal Crafts Inc.,** Chicago, Ill., has been announced by the **Precision Castings Co. Inc.,** Syracuse, N. Y. Affiliation with the **Wolverhampton Die Casting Co.,** Wolverhampton, England, was also announced by Precision Castings.

♦

Boots Aircraft Nut Corp., Stamford, Conn., has licensed the **Illinois Tool Works** to manufacture its Tri-Lok and Hex-Lok self-locking nuts for general industrial use. Illinois Tool will manufacture the nuts at its plant in Elgin, Ill. The Boots company will continue to supply the aircraft industry.

♦

Fidelity Chemical Products Corp., manufacturer of industrial metal treating and cleaning compounds for all purposes, has moved to larger quarters at 470 Frelinghuysen Ave., Newark, N. J.

♦

Hyatt Bearings Division, General Motors Corp., Harrison, N. J., producer of roller bearings for automotive, agricultural, industrial and railroad applications, has announced that work has commenced on a 125,000-sq ft extension to its second plant in nearby Clark Township. The expanded plant area is expected to be ready for occupancy shortly after the first of the year.

♦

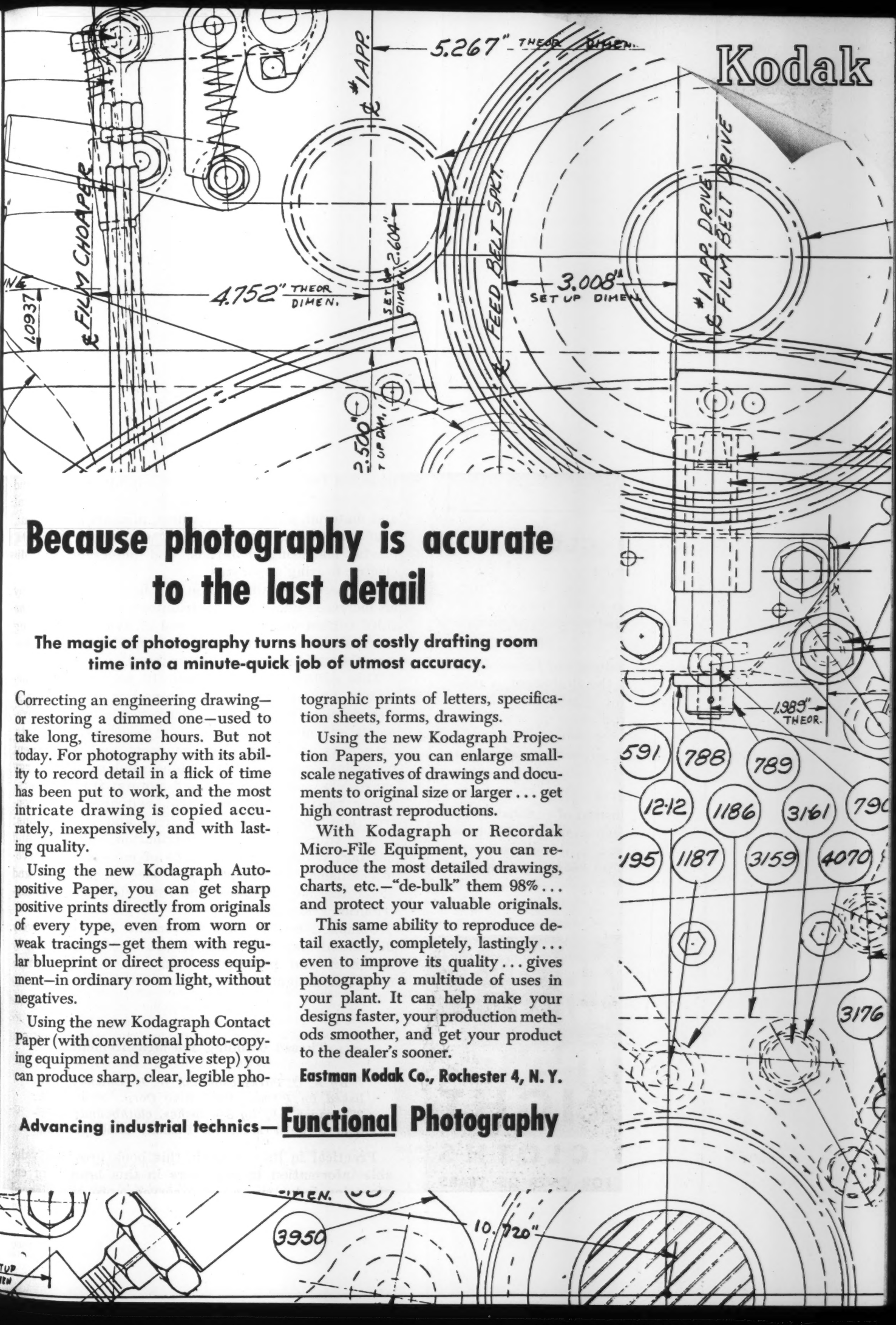
The **American Machine and Foundry Co.,** New York, N. Y., manufacturer of high-precision, automatic machinery, has acquired **Union Machinery Co.,** Joliet, Ill., manufacturer of bakery equipment.

♦

Purchase of the **Electrimatic Valve Div.** of the **Simoniz Co.,** Chicago, has been announced by the **Jas. P. Marsh Corp.,** Skokie, Ill. The Electrimatic line of automatic valves will be manufactured and distributed by the Marsh corporation.

♦

Patent, manufacturing and sales rights of the Barter-Ritco reversible grinder dog, formerly manufactured by the **Rhode Island Tool Co.,** Providence, R. I., have been acquired by the **Ready Tool Co.,** Bridgeport, Conn. Machinery and equipment for the manufacture of the grinder dog will be transferred to the Ready plant in Bridgeport.



Because photography is accurate to the last detail

The magic of photography turns hours of costly drafting room time into a minute-quick job of utmost accuracy.

Correcting an engineering drawing—or restoring a dimmed one—used to take long, tiresome hours. But not today. For photography with its ability to record detail in a flick of time has been put to work, and the most intricate drawing is copied accurately, inexpensively, and with lasting quality.

Using the new Kodagraph Autopositive Paper, you can get sharp positive prints directly from originals of every type, even from worn or weak tracings—get them with regular blueprint or direct process equipment—in ordinary room light, without negatives.

Using the new Kodagraph Contact Paper (with conventional photo-copying equipment and negative step) you can produce sharp, clear, legible photographic prints of letters, specification sheets, forms, drawings.

Using the new Kodagraph Projection Papers, you can enlarge small-scale negatives of drawings and documents to original size or larger . . . get high contrast reproductions.

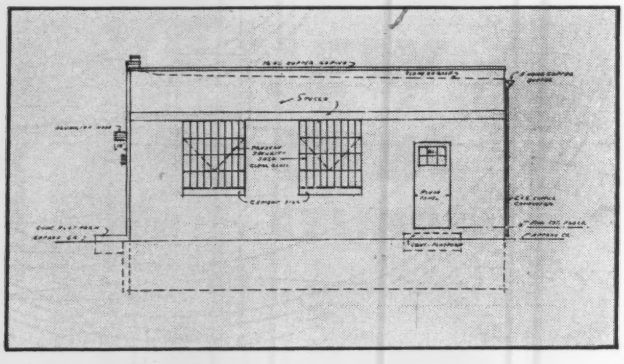
With Kodagraph or Recordak Micro-File Equipment, you can reproduce the most detailed drawings, charts, etc.—"de-bulk" them 98% . . . and protect your valuable originals.

This same ability to reproduce detail exactly, completely, lastingly . . . even to improve its quality . . . gives photography a multitude of uses in your plant. It can help make your designs faster, your production methods smoother, and get your product to the dealer's sooner.

Eastman Kodak Co., Rochester 4, N. Y.

Advancing industrial technics—Functional Photography

with CONCRETE
— the small extra first cost of test samples pays off in assurance of efficiency and durability of the finished structure.



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Arkwright gives both immediate *and* future advantages. The expert work of the draftsman is made permanent. Your investment in time and money is backed by sharp, clean reproductive quality. Under repeated use — or on file for subsequent need — Arkwright assures perfect drawing performance year after year.

For every drawing worth keeping for future use — use permanent Arkwright instead of perishable tracing paper. Send now for generous samples and prove this superiority. Sold by leading drawing material dealers everywhere. Arkwright Finishing Company, Providence, R. I.

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1. Erasures re-ink without feathering.
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3. Tracings never discolor or go brittle.
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TRACING CLOTHS
AMERICA'S STANDARD FOR OVER 25 YEARS

THE ENGINEER'S LIBRARY

Electrical Engineers' Handbook
Volume I—Electric Power

Edited by Harold Pender, consultant, and William A. Del Mar, chief engineer, Habirshaw Cable and Wire Div., Phelps-Dodge Copper Products Corp.; published by John Wiley & Sons Inc., New York; 1716 *pages,* 5⅝ *by* 8⅝ *inches, clothbound; available through* MACHINE DESIGN, $8.50 *postpaid.*

In the new fourth edition of this well-known engineering reference all features which highlighted the earlier editions have been retained and supplemented with increased attention to several of the subjects which have assumed new importance. Notable among these, on the theoretical side, are circuit stability and symmetrical components; among items of equipment and material, electronic rectifiers, aircraft equipment, heat pumps, servomechanisms, permanent magnets, plastic insulating materials, and induction and dielectric heating apparatus.

Increased specialization in the field is reflected by an increased number of contributors. Whereas in the third edition one author covered all types of rotating machinery, the fourth edition has five authors to discuss the various phases of the subject.

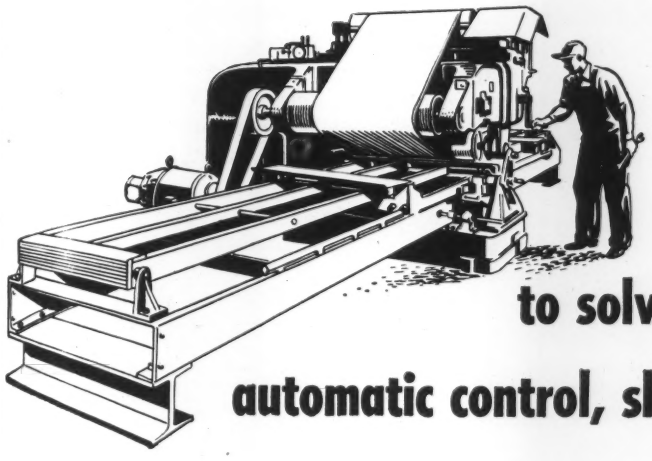
This edition is divided into 19 sections: Mathematics, units and symbols; properties of materials; electric circuits and lines; electrochemistry; measurements and measuring apparatus; resistors, rheostats. capacitors, reactors, electromagnets and permanent magnets; batteries; d-c machines and rotary energy converters; a-c generators and motors; transformers; power rectifiers and inverters; switchgear and control equipment; power stations and substations; power transmission and distribution; lighting and heating; industrial applications of motors and servomechanisms; transportation; electrochemical and electrothermal processes; and rural electrification distribution systems.

Compact, concise and convenient, this effectively illustrated handbook should prove of considerably increased and permanent value to electrical engineers and designers.

Thread Grinding and Measurement

By A. C. Parkingson and W. H. Dawney; published by Pitman Publishing Corp., New York; 227 *pages,* 5½ *by* 8½ *inches, clothbound; available through* MACHINE DESIGN, $4.50 *postpaid.*

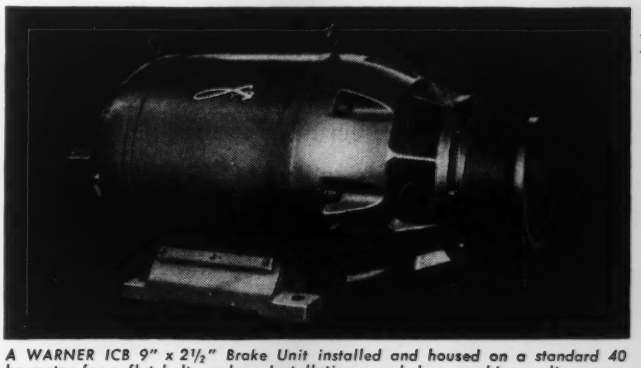
Practical in its approach, this book provides valuable information to beginners in this branch of engineering industry and also serves more experienced personnel as a useful reference on both the production



Smart design engineers use WARNER ICB UNITS to solve problems of clutching, braking, automatic control, shock and torque on their products

IF YOUR PROBLEM

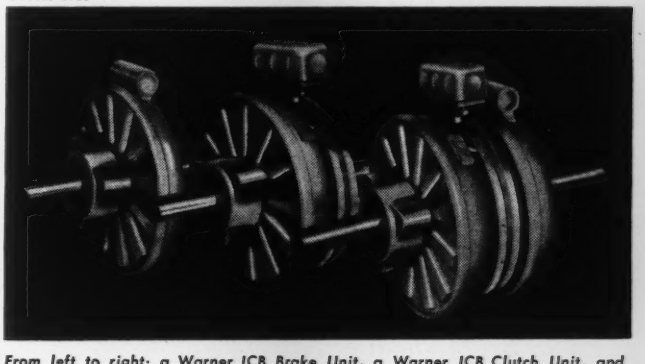
is to design your machine or its activating parts so that *you get:* (1) Push-button actuation at the machine or a remote control panel. (2) Fully or semi-automatic operation in "stop" or "start" of machine cycles. (3) Controlled acceleration or deceleration. (4) Automatic or manual adjustment of torque to load . . . or if your problem is *to eliminate:* (1) "Shock" from stop or start on gear trains and shafts. (2) Complex mechanical lever linkage, or air and hydraulic piping systems. (3) Vibration and hammering from solenoid operated brakes and clutches . . . or if you want to *increase production* from your machine by increasing the speed and number of cycle operations —



A WARNER ICB 9" x 2½" Brake Unit installed and housed on a standard 40 hp motor for a flat belt sander. Installation speeded up machine cycling, gave better, faster operational control. Installation is simple, compact and readily accessible.

A GOOD SOLUTION

to any one or combination of these problems is WARNER ICB Units. WARNER ICB Units are electrically controlled and operated clutches and brakes. They are compact, mechanically simple and may be applied to machine spindles, drive shafts, or direct to electric motors. Because of their design, they may be operated individually or in combination, manually or automatically, by direct or remote control. They provide for infinite controlled variation of torque in either clutching or braking action within their rated capacities. Their action is smooth and shockless—fast and practically noiseless. They are self-adjusting and self-compensating for life. Their design guarantees a high rate of heat dissipation.



From left to right: a Warner ICB Brake Unit, a Warner ICB Clutch Unit, and a combination Warner ICB Clutch and Brake Unit. Note clean, smooth, compact, appearance — simple mechanical parts.

MORE INFORMATION

on WARNER ICB Units and their application as clutches or brakes to various kinds of machinery is available. They may be used on continuous or intermittently operated machines. There is a complete range of sizes to meet both braking and clutching torque needs. If you have a design problem such as indicated above, write today for our free bulletin No. 701. If possible, state your problem. Not only will you receive your bulletin copy, but experienced WARNER ICB engineers will be glad to consult with you without obligation. Write direct to WARNER ELECTRIC BRAKE MANUFACTURING COMPANY, Beloit, Wis.

Bulletin 701 contains complete specifications and description of WARNER ICB Units. See for yourself how they offer advantages never before available on industrial clutches and brakes. Write for it today — no charge.

WARNER ICB UNIT

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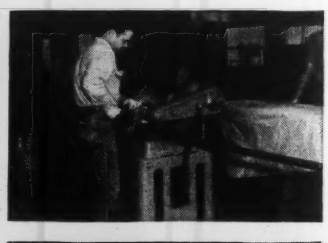

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and inspection aspects of thread grinding.

Phases of the subject covered include: Machines employed, machine setting, grinding wheels, coolants and lubricants, crushing rollers and their uses, change wheels and change-wheel calculations, grinding internal threads, surface finishing, and production time calculations.

Considerable space is devoted to the wire methods of thread measurement. Thread terms and definitions are classified and explained in detail, as are limit systems in general and their special applications to screw threads, worms and hobs. A considerable number of useful tables, all having direct relevance to precision screw-thread production and measurement are included.

History of the Tools Division, W.P.B.

By Bradley Stoughton; published by McGraw-Hill Book Co. Inc., New York; 154 *pages,* 6 *by* 9 *inches, clothbound; available through* MACHINE DESIGN, $4.00 *postpaid.*

Co-ordination on an extensive scale was necessary to yield the tremendous production of the war years. The men who contributed their talents to the Tools Division, largest group of the War Production Board, the problems which faced them and the results they achieved are the subjects treated in this book.

An extensive chapter is devoted to biographical material with regard to every individual concerned with the Tools Division. On the whole the material presented in the book is of import, not so much from the standpoint of biographical data, although this space is informative and justified, or from the standpoint of historical record, but more so from the standpoint of organization methods and manufacturer-government correlation toward a desired end.

This is more than a text on production approach. It is the narration of experiences encountered during a period when peak production was vital. The problems and their solutions form a body of information valuable to the engineer and executive in that it fosters a better understanding of proved, practical methods used in consolidating widely scattered units into an efficiently productive organization.

Heat Transfer, Vol. I

By Max Jakob, research professor of mechanical engineering, Illinois Institute of Technology, consultant in heat research, Armour Research Foundation, nonresident research professor of heat transfer, Purdue University; published by John Wiley & Sons Inc., New York; 758 *pages,* 6 *by* 9 *inches, clothbound; available through* MACHINE DESIGN, $12.00 *postpaid.*

This book should serve designers, engineers and physicists alike. A comprehensive work suitable both as a treatise and a textbook, it shows the development of ideas which have led to the present knowledge of heat transfer.

Parallel treatment of conduction, convection and radiation emphasizes their peculiarities and interrela-

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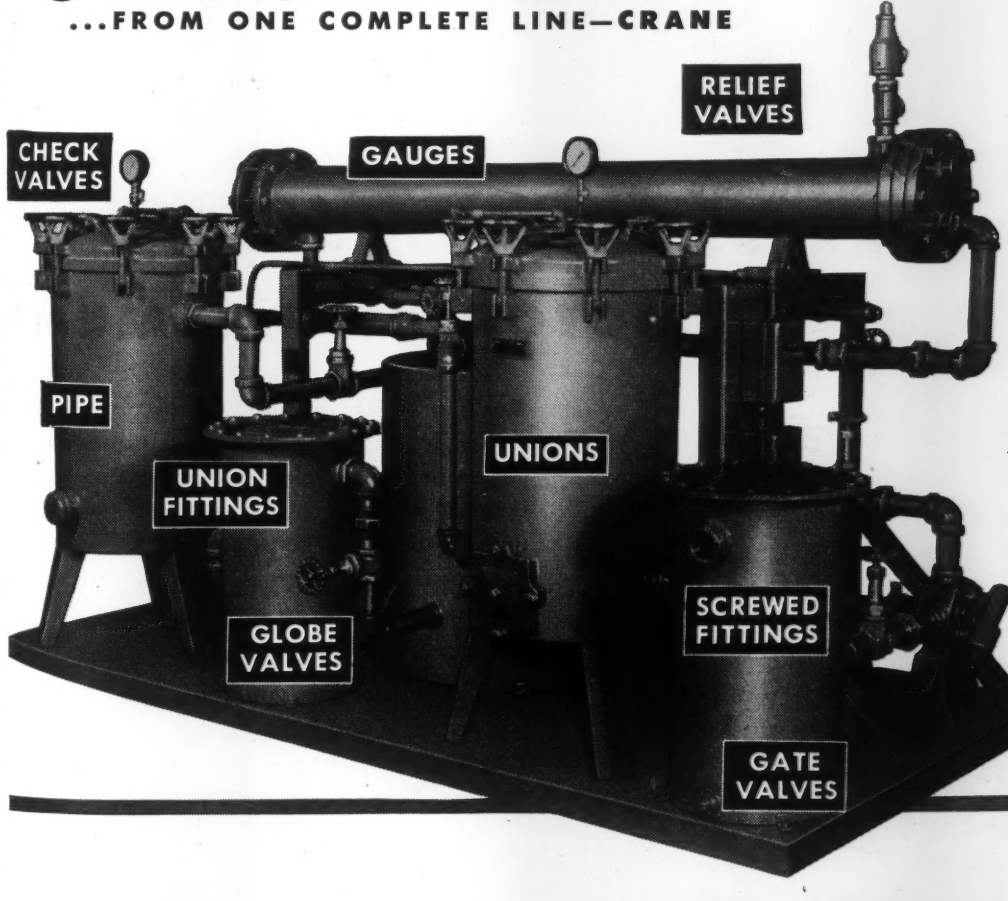

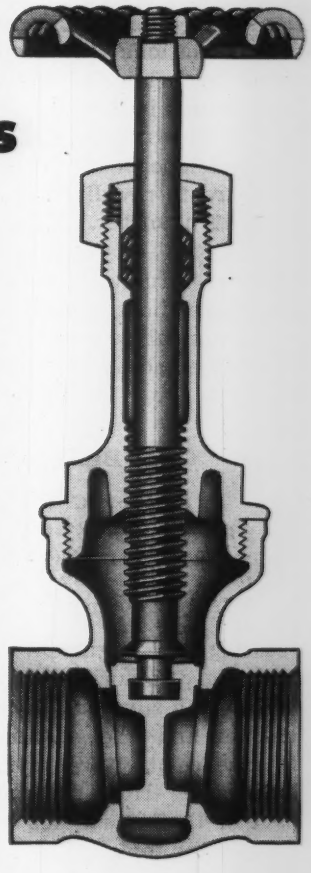

RUGGED AND DURABLE, *Crane No. 428 Brass Gate Valves have solid wedge disc accurately guided to prevent contact between seating surfaces until valve is almost closed. Rising stem; screwed ends. Working pressures: 125 pounds steam, 200 pounds water, oil, or gas. Sizes: ¼ to 3 in. See your new No. 49 Crane Catalog, p. 16.*

Heat Exchanger by Bell & Gossett Co., Morton Grove, Ill.

EVERYTHING FOR EVERY PIPING SYSTEM **CRANE**

VALVES • FITTINGS • PIPE • PLUMBING AND HEATING

tionships. The first part of the book contains the basic equations; the second part deals with the pertinent properties of matter. Mathematical procedure is explained in detail; empirical material is used mainly for illustration, for verification, or for showing the deficiencies of theoretical analysis. Much of the book treats peculiarities of matter which play a role in heat transfer. Attention is directed to the influences of chemical composition, state of phase, physical structure, quality of surface, temperature, etc. Appendices contain problems to be solved, a list of the symbols most often needed and other informative and useful material.

Giant Brains—Machines that Think

By Edmund C. Berkeley, president E. C. Berkeley and Associates; published by John Wiley & Sons Inc., New York; 270 pages, 5½ by 8½ inches, clothbound; available through MACHINE DESIGN, *$4.00 postpaid.*

Designers, engineers and scientists have found increasingly important the need for devising mechanisms which substantially eliminate manual and mental efforts and the associated element, human error. In essence they are duplicating the human brain with hardware. How they accomplish this and the impact of their machines on society, discussed in terms understandable by the layman, are the subject of this book.

To illustrate the 'brain character' of the machines, the author draws a comparison between the human brain and its nerve system and the machine and its devices. Beginning with the simplest of mechanical brains, the author develops this 'Simple Simon' to the point where it can receive, store, transmit, compute and reason under human control. Thus grounded, the reader is introduced to the giant brains in existence today. Among these are the IBM punch-card machines, Massachusetts Institute of Technology's differential analyzer No. 2, Harvard's automatic sequence-controlled calculator, Moore School of Electrical Engineering's electronic numerical integrator and calculator (Eniac), and Bell Telephone Laboratories' general-purpose relay computer. Each of the machines is discussed with respect to general organization, physical devices and method of handling information; the machine is then appraised from the standpoints of speed, cost and value, reliability, and efficiency.

Finally, the author analyses a machine which is a logician rather than a mathematician, the Kalin-Burkhart logical truth calculator, whose main function is to determine what is logically true and what is logically false. Concluding philosophically, the author anticipates future designs of machines that think and benefits to be expected if the machines are properly handled.

New Standards

The 1949 edition of *Hydraulic Standards for Industrial Equipment* has been issued by the Joint In-

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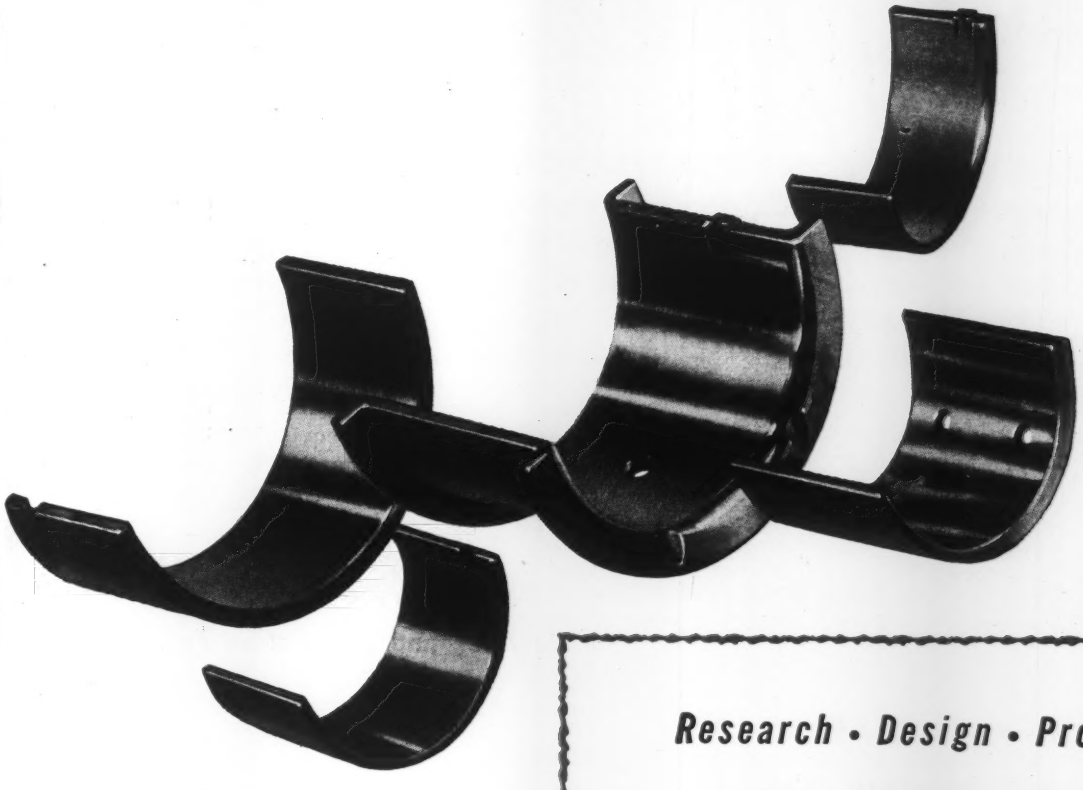

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dustry Conference. The new edition contains a number of additions and corrections to the original standard, which was published in the December, 1948, issue of MACHINE DESIGN. A limited number of copies are available for distribution and may be obtained by contacting J. C. Rauss, Production Engineering Section, 15-288 General Motors Bldg., Detroit 2, Mich.

Tentative drafts of the following proposed American Standards are being distributed for comment:

Large Rivets, ASA B18.1 . . .
Lock Washers, ASA B27.1 . . .

Engineers concerned with the subjects of these standards may obtain copies by writing to S. A. Tucker, standards manager, The American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.

Manufacturer and Association Publications

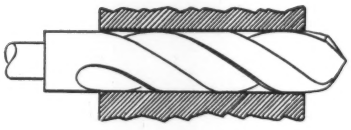
Handbook on Synthetic Rubber Packings: Third edition prepared by the Hydraulic Engineering Dept., E. F. Houghton & Co. This 110-page manual contains considerable design and application data on the VIX-SYN fabricated and homogeneous synthetic rubber packings, leather back-up washers for O-ring packings and gaskets, and O-ring gaskets and back-up washers for bulkhead fittings. Incorporated are the standards approved by the Joint Industry Conference in 1949. Copies of the manual may be obtained by writing to E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa., on company letterhead.

Principles of Magnaflux: Written by F. B. Doane, president Magnaflux Corp. and C. E. Betz, vice president, this extensively revised third edition covers the subject of magnaflux inspection from the basic electrical and magnetic principles to the latest and most effective production equipment. The book contains 388 pages and may be purchased from Magnaflux Corp., 5900 Northwest Highway, Chicago 31, Ill., $5.00 postpaid.

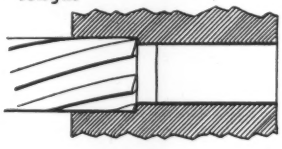
Shock-Proof: A 92-page manual on the applications, machinability, users' specifications, finishing operations, etc., of malleable-iron castings. Copies may be obtained by directing company-letterhead requests to The Lake City Malleable Co., 5000 Lakeside Ave., Cleveland 14, O.

The Varnished Insulation Story: An 88-page book covering the purpose of varnished insulations, their origins and development, and their use in rotating apparatus, transformers, cables, power distribution systems, motor controllers, and electronic equipment. Copies are available from the National Electrical Manufacturers Association, 155 East 44th St., New York 7, N. Y. Price, $2.00 per copy.

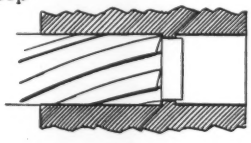
THE OLD WAY



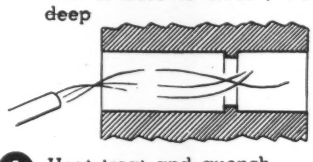
1. Drill 25.5 m.m. (1.004") hole full length



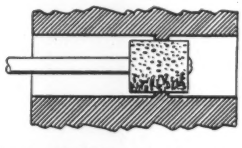
2. Machine bore to 1.761", .9975" deep



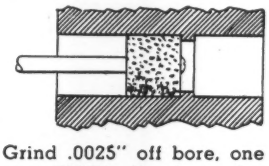
3. Rechuck and machine opposite end of bore to 1.761", 1.9355" deep



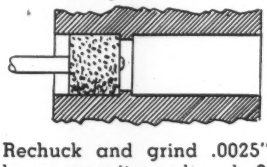
4. Heat treat and quench



5. Grind .00355" off shoulder inside diameter

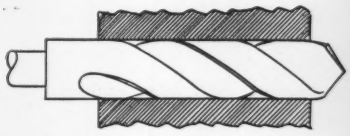


6. Grind .0025" off bore, one end and 0025" off side of shoulder

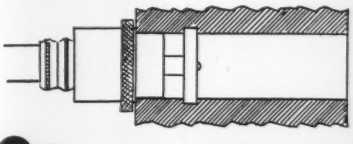


7. Rechuck and grind .0025" off bore, opposite end and .0025" off side of shoulder

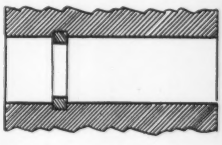
RELIANCE WAY



1. *Drill 1.811" (30 M.M.) hole, full length



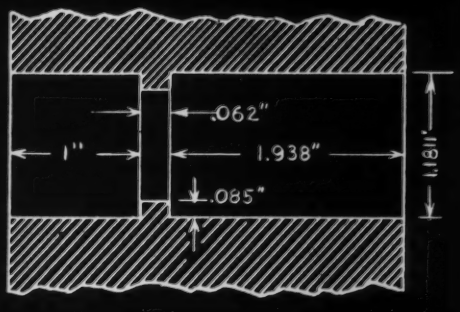
2. Recess groove .074" wide and .040" deep in bore, 1" from end



3. Snap Reliance Ring in groove

* For some applications, seamless tubing may be used, eliminating all drilling

No heat treating is normally required as ring is already hardened. No danger of warpage. If bore must be hardened, it may be ground in one pass after heat treating.



HOW RELIANCE RINGS

(AND GROOVING TOOL)

Slash the Cost of internal shoulders

The drawing and comparison chart above show how Reliance Rings and the Reliance Grooving Tool slashed the cost of internal shoulders on a typical application, eliminating four operations — savin gtime and money.

Reliance Snap Rings are available in carbon, alloy, stainless steel or non-ferrous metal to specified physicals, cross sections and diameters—ends shaped to meet any requirement. Reliance Rings offer opportunities for cost reduction, time saving and product improvement limited only by human ingenuity in finding new uses for them.

Reliance engineers will be pleased to study your prints or parts and lend the benefit of their experience in considering possible application of Reliance Rings to your product. Or, if you prefer, a competent representative will call to discuss the possibilities with you. Write, phone or wire your nearest Reliance Sales Office

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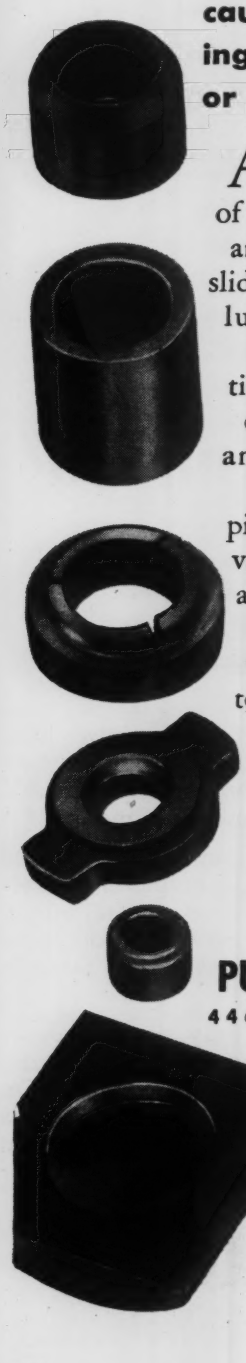
Purebon

solves many problems

caused by sliding or rotating parts which are difficult or impossible to lubricate



A constantly increasing stream of problems are facing engineers and designers today involving sliding or rotating parts where lubrication is difficult or impossible. For such applications, Purebon, the mechanical carbon, is often the ideal answer. Typical applications are seal rings, bearings, pistons, piston rings, pump vanes, valve seats, meter discs, and a host of similar items. Purebon comes in a wide variety of grades. It is strong, tough, readily machineable and in many cases can be molded directly to size.

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PROFESSIONAL VIEWPOINTS

". . . new and stimulating viewpoint"

To the Editor:

Compliments to Mr. Varnum on his good work in analysis of relay circuits! The design of complex circuits is more art than science, and requires a specialized type of thinking and experience in circuit design. This article is indeed timely and the method of analysis should be helpful in developing *all* of the conditions obtainable from a circuit. I am reminded of my own efforts when I was working on the control criterion ("Designing Control Circuits," MACHINE DESIGN, April and May, 1941), and it is interesting to note that odd-even algebra can be applied to reach the same conclusions that I obtained with somewhat less tangible means. Inexperienced control designers attempt to use relay contacts for too many functions, or they may design a circuit with two or more contacts duplicating a single function. Odd-even algebra might be applied as a check to eliminate such errors in design.

The formula for parallel circuits is somewhat complex. Since machine controls are made up mostly of parallel circuits, it might be helpful to reverse the definitions 1 and 2 on Page 137. This would also reverse the definitions 3 and 4 for series and parallel circuits and simplify the calculation of parallel circuits while complicating the series circuit analysis. Or, one might use both sets of definitions, making all series circuit calculations first and switching definitions before attacking parallel circuit analysis.

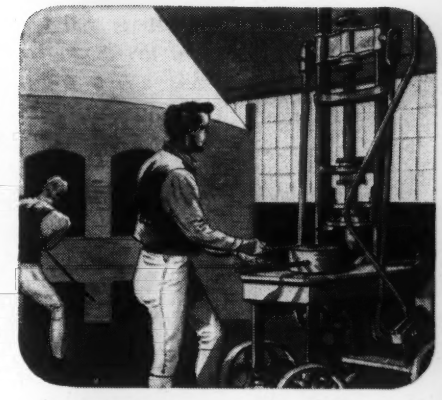
It might be well to mention the application of Boolean algebra to the analysis of relay circuits. In Boolean algebra $x + x = x$ and the formula for parallel circuits is $x + y$, the formula for series circuits being xy as in the case of the odd-even algebra. There is an arithmetic conception in the odd-even algebra that is very much in keeping with the "on-off" condition of a relay circuit, and I personally would prefer the odd-even over the Boolean algebra for this reason.

Thank you for presenting this article. It offers a new and stimulating viewpoint on an old problem, and Mr. Varnum is to be commended on his accomplishment.

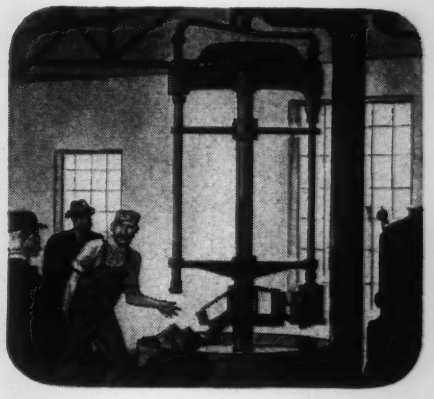
—R. S. ELBERTY
Consulting Engineer
Southington, Conn.

ALTHOUGH the horse is now regarded as a symbol of a bygone age, modern mass production methods have found their way into the manufacture of horseshoes. Phoenix Mfg. Co., of Joliet, Ill., now butt welds toe calks to the shoe proper on a dial-fed automatic resistance-welding machine, improving quality and doubling output.

1 **1621**—Glass was money! America's first glass factory was actually a mint—not for the manufacture of coins but to make glass beads for *use* as money when buying land, food and furs from the Indians.



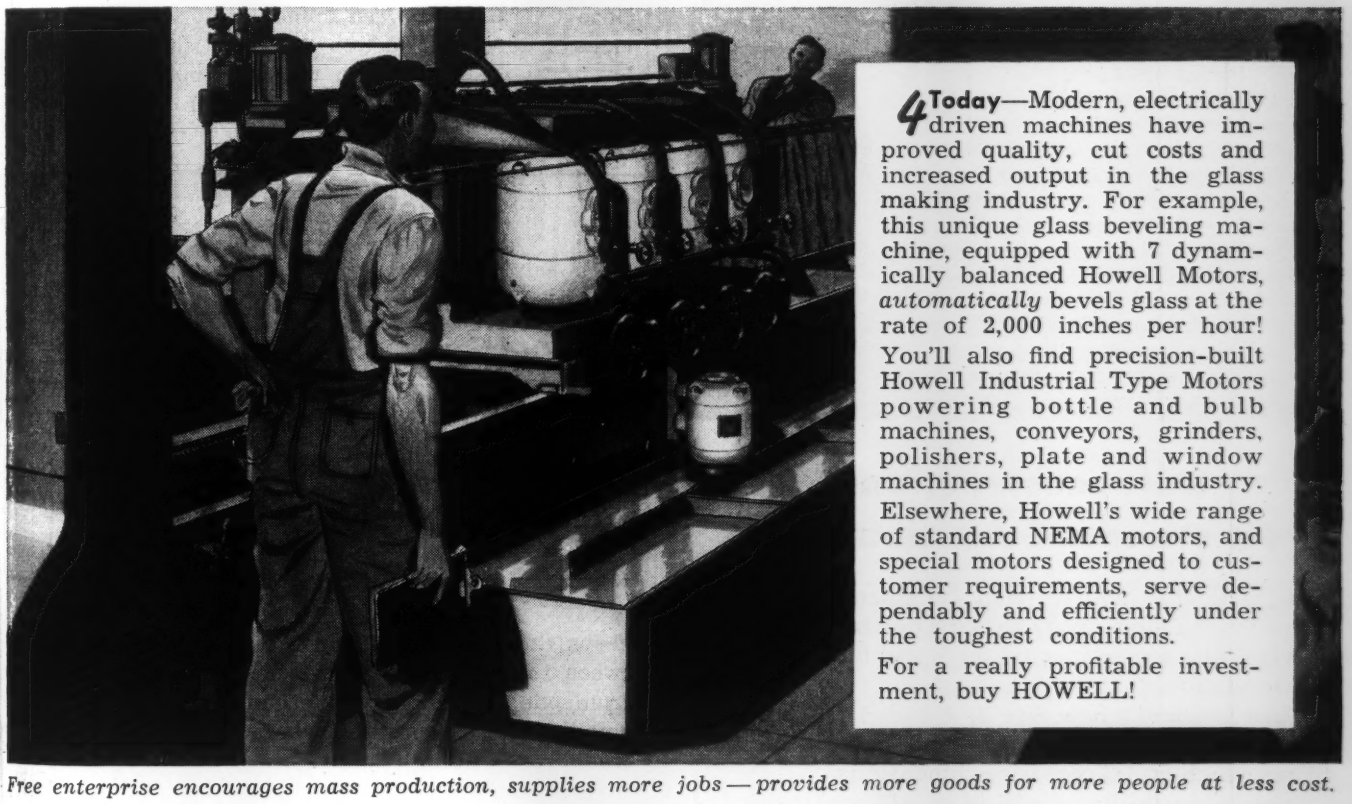
2 **1827**—Blown glass was the rule until Enoch Robinson, a carpenter, figured glass could be *pressed* into shape . . . the glass pressing machine was born. Electricity to power new machines was still to come.



3 **1899**—Owens invented a machine to make bottles as the machine age arrived in glass. By 1915, Howell "Red Band" Motors were making important contributions to this and other industries.

ANOTHER HOWELL SUCCESS STORY

GLASS...from artisans to automatic machines



4 **Today**—Modern, electrically driven machines have improved quality, cut costs and increased output in the glass making industry. For example, this unique glass beveling machine, equipped with 7 dynamically balanced Howell Motors, *automatically* bevels glass at the rate of 2,000 inches per hour!

You'll also find precision-built Howell Industrial Type Motors powering bottle and bulb machines, conveyors, grinders, polishers, plate and window machines in the glass industry.

Elsewhere, Howell's wide range of standard NEMA motors, and special motors designed to customer requirements, serve dependably and efficiently under the toughest conditions.

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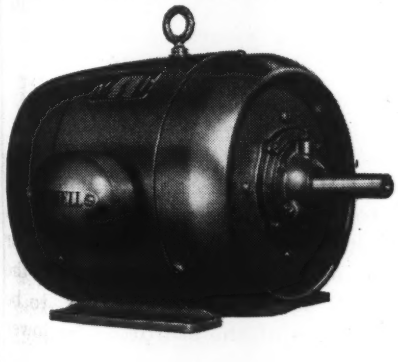
Free enterprise encourages mass production, supplies more jobs — provides more goods for more people at less cost.

Howell totally enclosed, fan-cooled motor—windings completely sealed against dirt and weather.

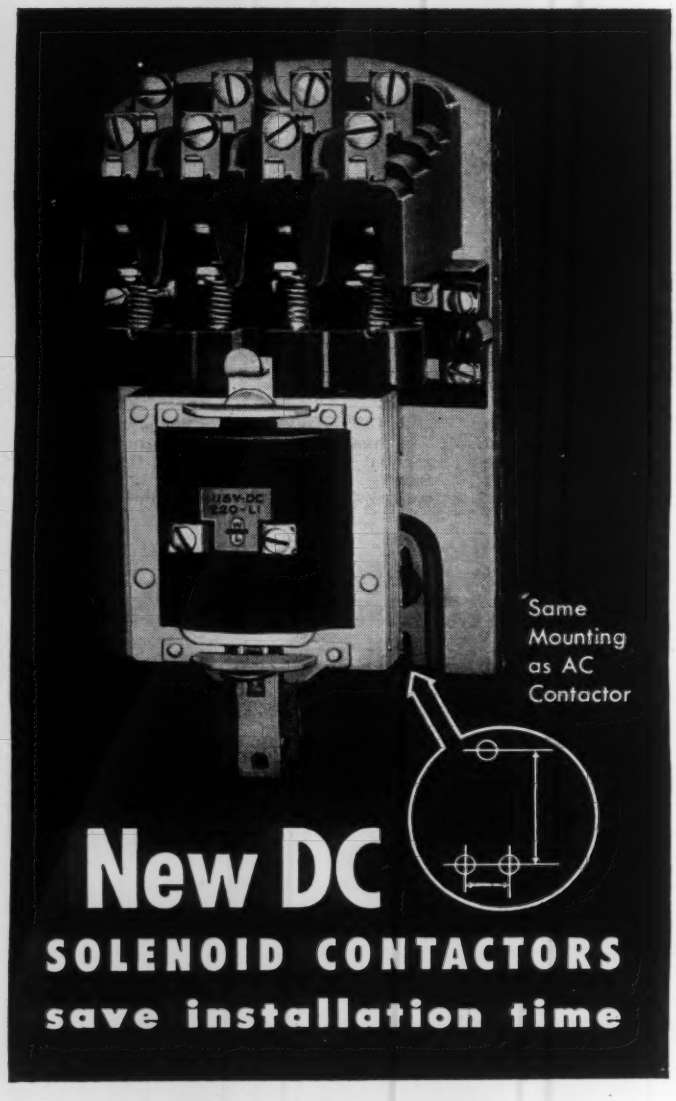


HOWELL MOTORS

HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.

Precision-built Industrial Motors Since 1915

HOWELL Red Band MOTORS



New DC
SOLENOID CONTACTORS
save installation time

Unit construction—
Fit standard AC mounting

Now, with this modern, compact solenoid-type contactor . . . you'll no longer have the nuisance of drilling special holes for each component and furnishing special insulation.

Ward Leonard's new Size 1, 2 and 3 DC Solenoid Contactors are *unit-insulated*—and have metal base plates which fit AC contactor dimensions.

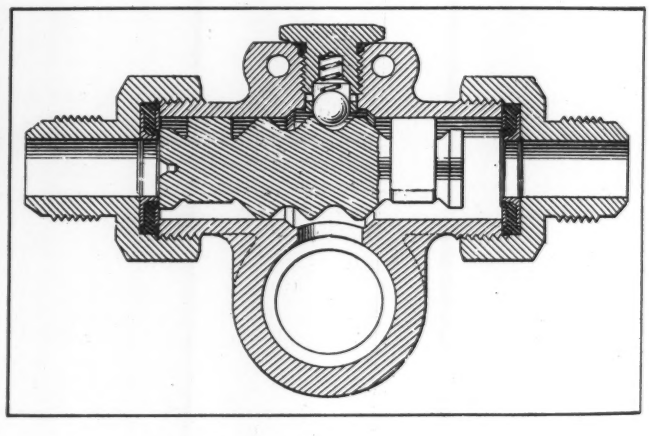
Same accessibility of wiring as AC contactors . . . silver-to-silver contacts . . . components interchangeable with AC contactors.

Write for new Bulletin 1950. WARD LEONARD ELECTRIC CO., 58 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD
ELECTRIC COMPANY
Result-Engineered Controls
RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

NOTEWORTHY PATENTS

HIGH-VELOCITY FLOW past the rubber seating portion of fluid valves is reduced as described in patent 2,481,460 assigned to the Parker Appliance Co. by Eugene D. Williams. Resulting in decreased wear on the valve seats, particularly under conditions of partial valve closure, the valves employ rubber rings embedded in the end sealing faces of metal rings or bushings through which the fluid passes. When the valve starts to open, a section having a close tolerance between spindle and valve body provides a throttling action to keep the fluid velocity low until the valve is in the fully open position. A spring-loaded ball, engaging grooves in the spindle,



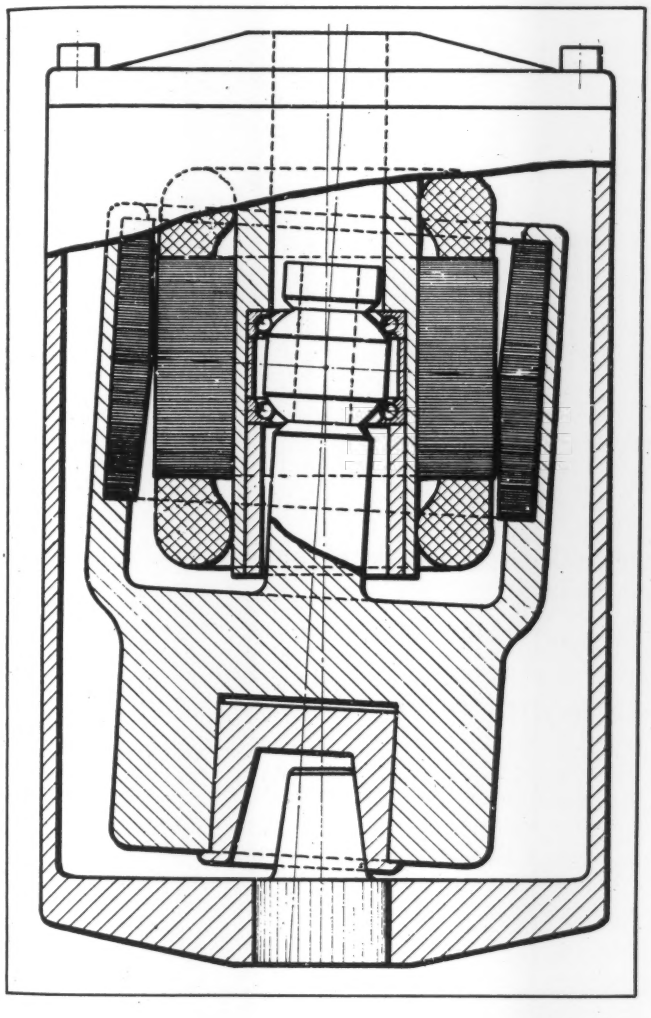
keeps the valve seated until differential pressure between the two inlets is sufficient to snap the spindle from one position to the other, tending to snap the spindle past the position where a small port opening would result in high fluid velocity.

In other words, there will not be a high velocity flow past the seating portion even though the valve should hover or stop after it leaves its seat, or move slowly away from the seat, because at such a position the only flow past the seat is the slight amount passing through the annular clearance between the shuttle valve member and the casing body.

CONICAL PENDULUM principle is employed in an electric vibration motor to produce variable vibration frequencies without the use of eccentric weights or gear trains. A single spherical bearing permits the axis of the rotor, which surrounds the stator, to be tilted in relation to the axis of the stator. The lower

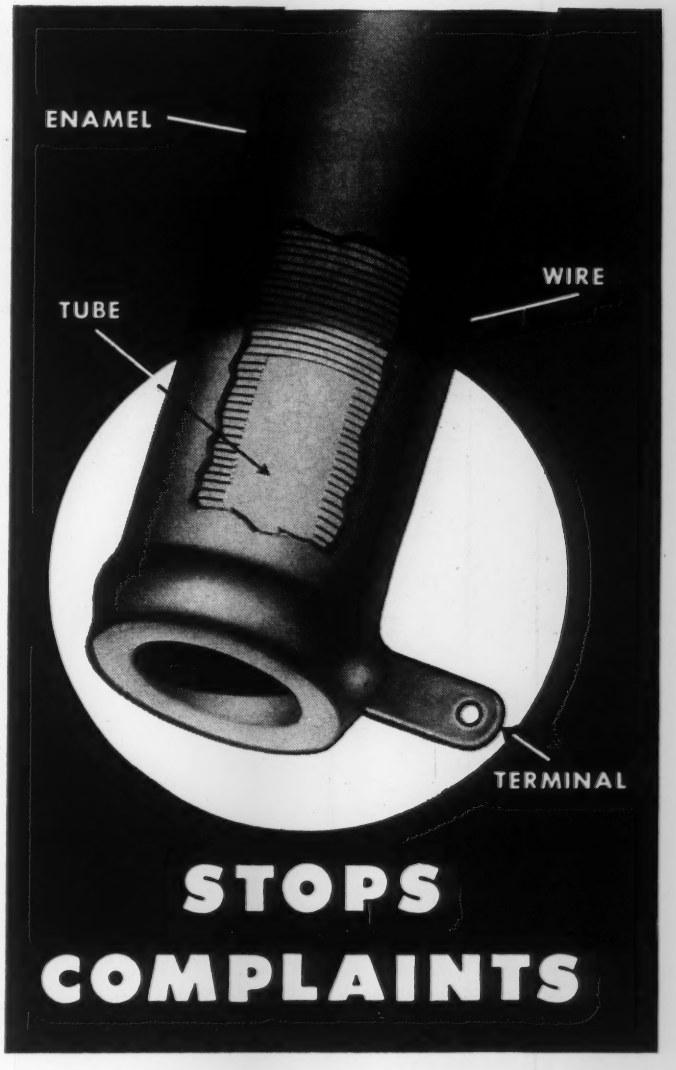
end of the rotor contains a bushing with a cone-shaped cavity that rolls around a stationary pivot attached to the motor frame. This rolling gives the rotor an action similar to that of a pinion in a planetary gear train. Vibration frequency can be varied by changing the ratio of the diameters of the surfaces of revolution of pivot and bushing.

The inner diameter of the rotor is tapered, the smallest diameter being at the center of the rotor coil. The unequal air gap thus created causes the field of force to be diagonally positioned between



stator and rotor—which tends to pull the rotor into the off-center position and gives the conical pendulum movement to the rotor. The patent, No. 2,480,825, has been granted to Friedrich Adolph and assigned to the Vibro-Plus Corp.

INVERTED CONE-SHAPED IMPELLER with shrouded, spiral fins is used in the vertical-flow fluid pump described in patent 2,483,335 to give a wide capacity range with little decrease in efficiency at lower outputs. A conical sleeve or shroud surrounds and rotates with the impeller fins, reducing fluid friction to a minimum since the rapidly rotating impeller does not throw the fluid out against a stationary housing or wall. Restricting the output does



because exclusive "component-matching" prevents failures

The sure way to avoid trouble due to resistor failure is to use the resistor with the *matched* components.

Ward Leonard alone *makes*—not just assembles—all the components of a resistor. (Wire is drawn to Ward Leonard specifications.) This means that all components are *balanced* in respect to thermal coefficient of expansion and other factors affecting service life. No loosening, no failure—because all parts react the same to their "environment."

Write for bulletin on Vitrohm Resistors, WARD LEONARD ELECTRIC CO., 58 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD ELECTRIC COMPANY

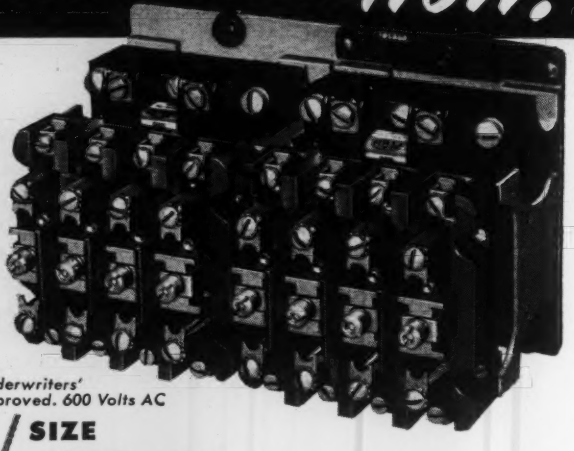
Result-Engineered Controls

RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

W L

Check

R-B-M INDUSTRIAL CONTACTORS NOW!



Underwriters' Approved. 600 Volts AC

SIZE

Non-Reversing

2 to 4 Pole 2-3/4″ w. x 3-5/8″ h. x 3-5/16″ d.
5 to 8 Pole 5-9/16″ w. x 3-5/8″ h. x 3-5/16″ d.

Reversing

2 to 4 Pole 5-9/16″ w. x 3-5/8″ h. x 3-5/16″ d.

Note: 10 and 15 ampere contactors have same mounting and overall dimensions.

ACCESSIBILITY

To replace contacts, it is not necessary to disassemble the complete contactor. Just remove the parts comprising the stationary and movable contacts. Contacts can be replaced without disturbing wiring. To change coil, remove magnet frame and coil assembly only. (See illustration below.)

FLEXIBILITY

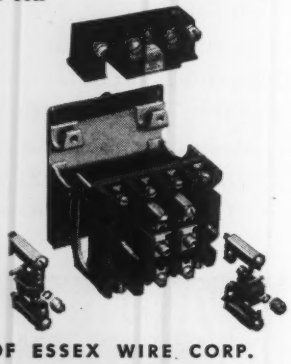
Using a screw driver only, you can easily change any pole from normally open to normally closed. No special parts required. 10 and 15 ampere parts are interchangeable.

RELIABILITY

Laboratory tests involving millions of operations, plus field service of thousands of R-B-M contactors on door operators, radio transmitters, packaging and weighing machinery, hoists, machine tools and many other industrial applications offer proof of dependable, trouble-free performance.

ADVANCED DESIGN

Melamine Insulation. Molded coil housing. Ilsco solderless connectors. 50/60 magnet coils. Palladium silver contacts. Stainless steel self-contained contact springs.

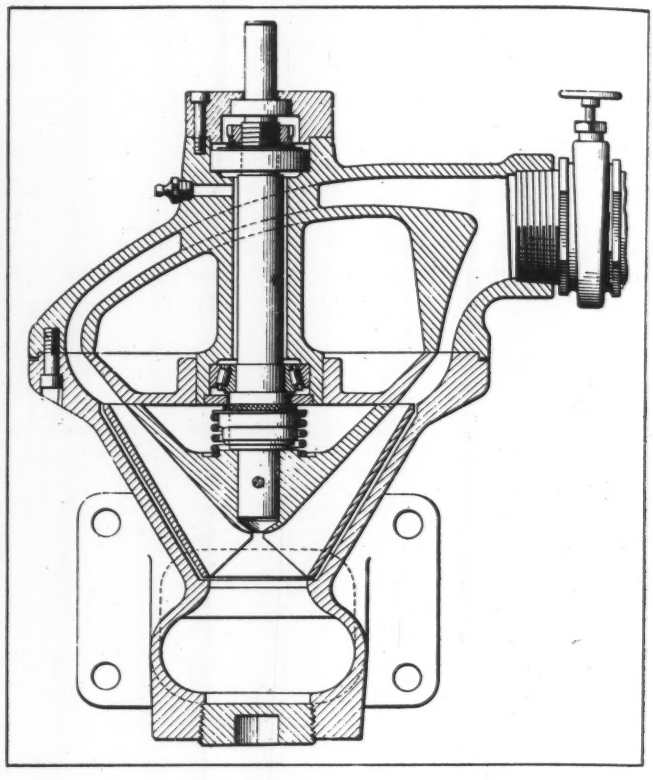


Where space is a factor, and accessibility a must—use R-B-M industrial contactors. Initial low cost plus dependable performance will save you money. Write for Bulletin 600 and price list on your company letterhead.

Dept. B-2, R-B-M DIVISION OF ESSEX WIRE CORP.
Logansport, Indiana

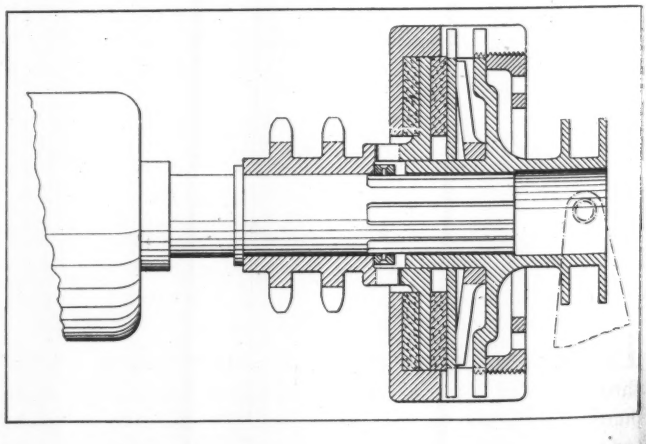
RBM

MANUAL AND MAGNETIC ELECTRIC CONTROLS
—FOR AUTOMOTIVE INDUSTRIAL COMMUNICATION AND ELECTRONIC USE



not build up excessive back pressures in the pump; therefore the power required to drive the impeller when the volume is decreased is substantially less. John H. Davis has assigned the patent to Jessie A. Davis Foundation Inc.

SMOOTH ENGAGEMENT of positive-jaw type couplings, while the driver is rotating, is accomplished without damage to clutch jaws or other rotating parts with an adjustable friction clutch. The device described in patent 2,482,007, assigned to Republic Aviation Corp. by Carl C. King, consists of one



set of jaws integral with the driven gear or sprocket and another jaw set on the driving disk of a friction clutch. Movement of an operating lever slides the friction members and driving jaws along the splined shaft and into engagement with the driven

AFTER 20 MILLION STROKES THESE LINEAR "V" RINGS WERE STILL GOING STRONG!

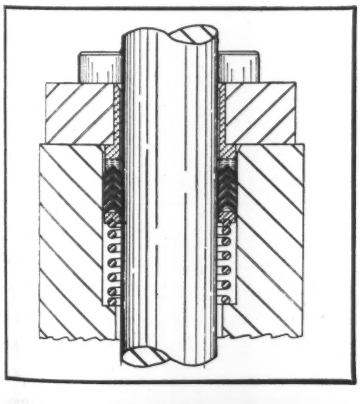
Another Proof-of-the-pudding Demonstration of LINEAR "V" RING Efficiency

This unretouched photograph shows a cut-away section of one of 3 sets of LINEAR "V" Ring packings. Each set was installed at 6-month intervals in a vertical triplex pump operating continuously for a year and one-half under actual service conditions. Throughout the entire 18-month period no maintenance or adjustments were required. When removed, each set was sealing as efficiently as when first installed . . . *and most important, all three sets had identical wear characteristics.*

Spring-loading the packing changed this installation from an adjustable gland to a fixed gland bolted metal-to-metal, thus providing automatic take-up to the packing installation. The result? Complete elimination of dangerous over-tightening of the packing and greatly improved seal life.* By using a spring-loaded installation with style M90 "V" Rings (specified for excellent abrasion resistance) a uniform and predictable packing life was determined from one installation to the next.

LINEAR offers industry a complete line of fabric reinforced and homogeneous "V" type packings for every service. They operate automatically from zero to peak pressures against air, steam, water, gas, oils and solvents over a wide temperature range.

For lowered packing costs and sealing devices of proven dependability, CALL LINEAR.



***PROGRESS REPORT OF SIX-MONTH SERVICE TEST:**

TYPE OF EQUIPMENT: Vertical Triplex Pump.

ROD MATERIAL: Cold drawn Monel.

FLUID PUMPED: River water containing solids of seven grains per gallon.

PACKING: Fabric top adapter with 5 pressure rings homogeneous type (LINEAR M90-V).

METHOD OF INSTALLATION: Packing set used with machined metal adapter installed with a coiled spring with a compression of 5 lbs. per inch of mean circumference for the spring load.

SPEED: 144 four-inch strokes per min.

HIGH PRESSURE: 10,108,980 strokes at 2250 psi.

LOW PRESSURE: 10,108,980 strokes at 0 psi.

TOTAL STROKES: 20,217,960.

"PERFECTLY ENGINEERED PACKINGS"

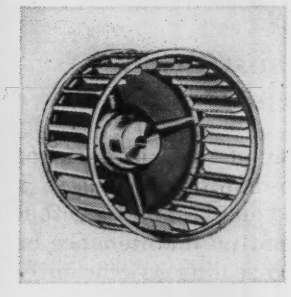
LINEAR

LINEAR, Inc., STATE ROAD & LEVICK STREET, PHILADELPHIA 35, PA.

Designers!

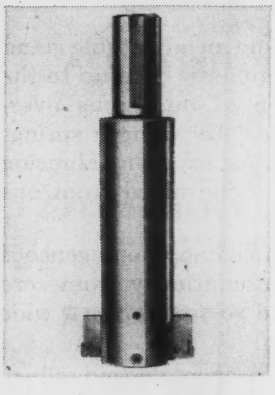
If you have either of these assembly problems—

Write for our helpful booklet



1 Make it tight against vibration

An air impeller, for example. The fasteners are under *continual* vibration. A famous manufacturer of air-moving equipment (name on request) uses Bristol's Multiple-Spline Socket Set Screws because the multiple-spline socket permits tightening much further than possible with any other screw.



2 Make it easy to adjust

Boring bars, for example, where the cutting blade is adjusted by turning a screw. A well-known tool manufacturer (name on request) uses Bristol's Multiple-Spline Socket Set Screws because the tight set is easily broken by a flick of the wrench—with no spoiled screws.

Multiple-Spline and Hex Socket Screws . . . Cap and Set

BRISTOL'S
SOCKET SCREWS

Only BRISTOL gives you the right Socket Screw for every application

SEND FOR FREE SAMPLE AND BOOKLET, USING COUPON

THE BRISTOL COMPANY,
Mill Supply Division
122 Bristol Road, Waterbury 91, Conn.

Please send free sample of Bristol's Multiple-Spline Screw and bulletin showing applications to: Screw Sizes.....

NAME.....

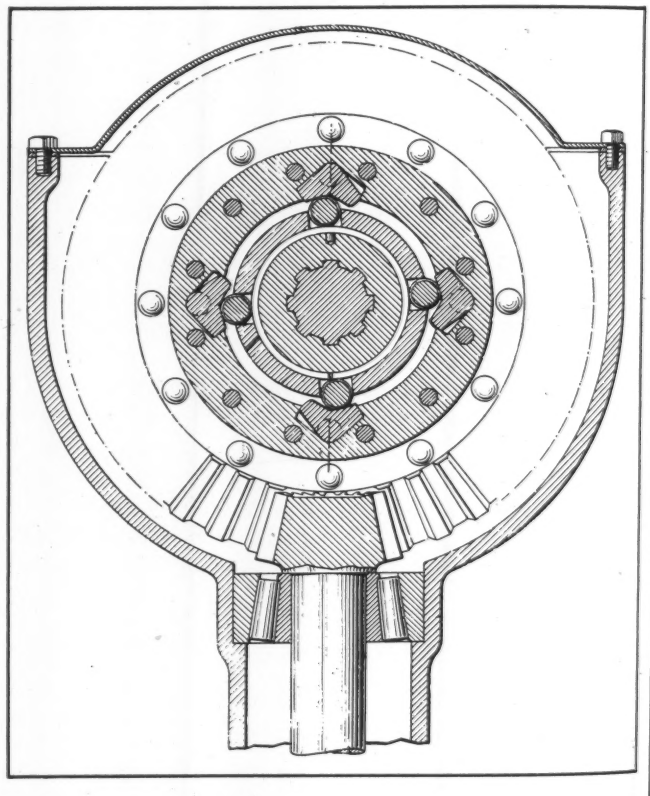
COMPANY.....

ADDRESS.....

CITY.....STATE.....

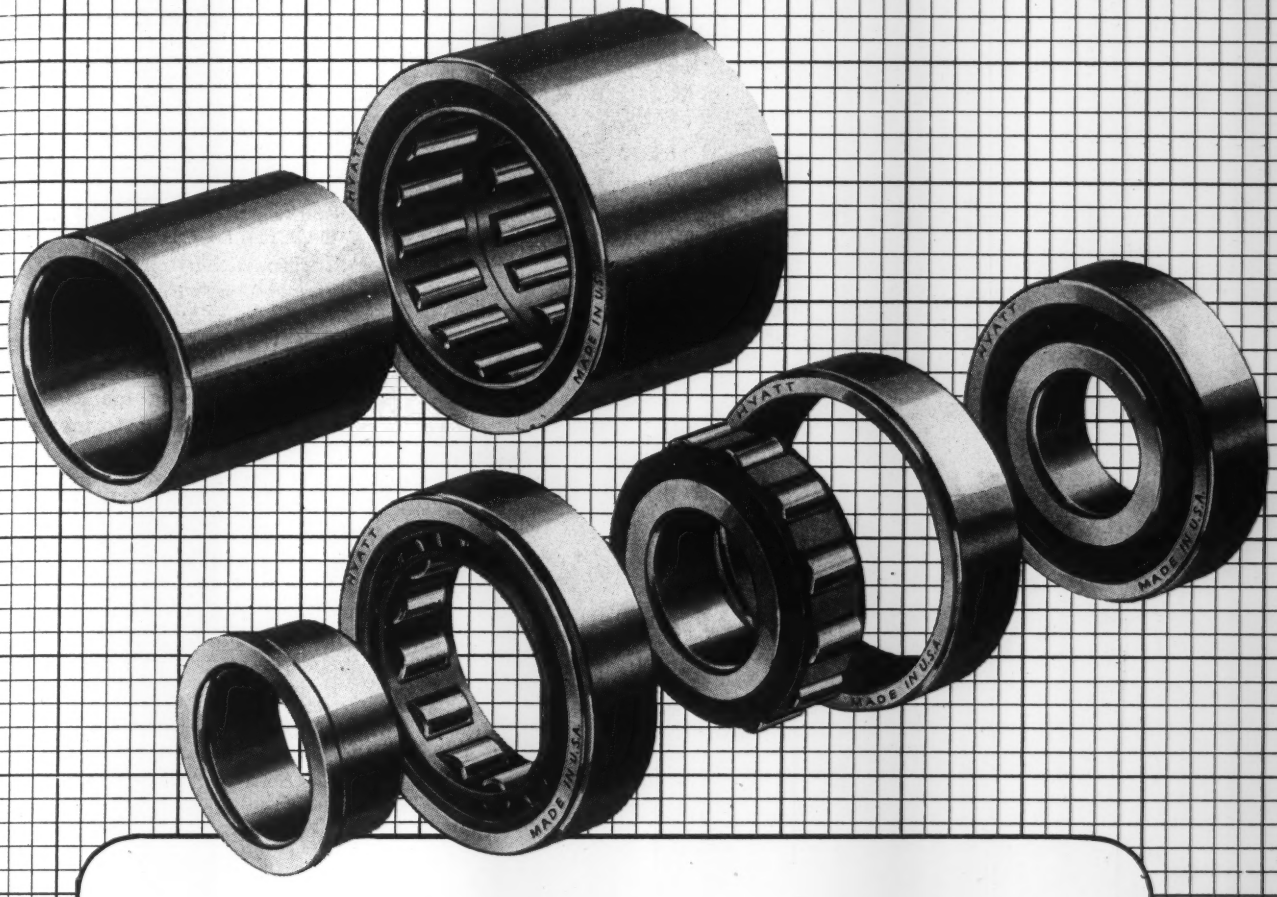
jaws. Initial shock and overloads are absorbed in the disk type friction clutch in which the release pressure is adjustable by varying the pressure of the spring fingers against the back of the clutch pressure plate.

REVERSIBLE OVERRUNNING CLUTCHES permit differential action in the automotive type transmission covered in patent 2,481,066, which functions in either a forward or reverse direction and when negotiating curves. The two drive axles are independently driven from the ring gear through roller type overrunning clutches, the wedging force occurring between pivoted, L-shaped cams or driving elements and the axle hubs. When turning a corner or when the drive wheels have unequal traction, a friction device mounted on the axle of the faster wheel causes the roller cage to overdrive the ring gear assembly, unlocking the driving cam from the axle as in a conventional clutch. When the rollers are in this idle



position, contact angle between cam and roller is too large to allow wedging. Reversible operation is possible because the driving cams are pivoted in the ring gear cases; i.e., when the ring gear is rotating in the reverse direction the other faces of the L-shaped cams become the locking faces, operation otherwise being the same as before. The Hughes Tool Co. has been assigned the patent by Walter Bagge.

Complete printed copies of all patents are available from the Commissioner of Patents, Washington 25, D. C., for 25 cents each.



Take Advantage of HYATT Experience

Hyatt Hy-Load bearings are high capacity cylindrical roller bearings. They are available in two diameter series, wide and narrow widths and standard AFBMA boundary dimensions.

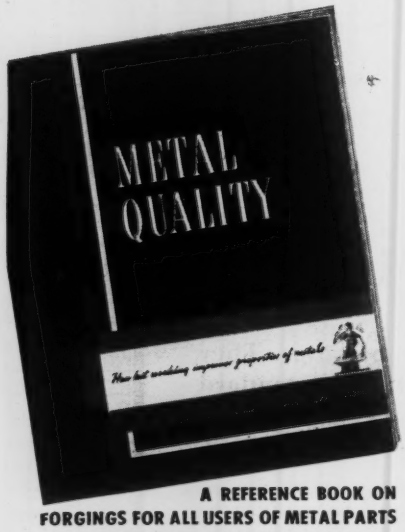
There are ten major types; four with separable inner races, two with separable outer races and four which are non-separable.

This wide range of available sizes and types, plus complete interchangeability of parts permits wide flexibility of machine design and assembly procedures.

Over the years, more and more design engineers have come to rely upon Hyatt for completely dependable bearing engineering. If bearings are part of the machine you are designing reach for your Hyatt catalog or make use of the Hyatt Engineering Service. For further information write to Hyatt Bearings Division, General Motors Corporation, Harrison, N. J., Chicago, Detroit, Pittsburgh and Oakland, Calif.

HYATT ROLLER BEARINGS

THE ONLY WAY YOU CAN BEAT FORGINGS AS A SALES FEATURE IS TO USE MORE FORGINGS



A REFERENCE BOOK ON FORGINGS FOR ALL USERS OF METAL PARTS

60 pages of authoritative information on metal quality as developed in forgings formed through the use of closed impression dies. Forging production techniques are described and illustrated; economic advantages of forgings are presented from the viewpoint of top management, design engineers, metallurgists and production executives. Your copy is ready. Fill in and attach coupon below to your business letterhead.

● What a forging *has*—can't be duplicated! No other method of fabricating parts utilizes fully the fiber-like flow line structure of wrought metals. Thus, forgings provide matchless capacity for the toughest work loads and fortify your product for better performance. Forgings forestall and reduce downtime due to failure of highly stressed parts; provide a factor of greater safety for men and machines. A recheck of every stressed part, as well as simple handles and levers, frequently reveals opportunities to improve a product, to reduce the cost of machining and finishing or to speed up assembly. Consult a forging engineer—only a forging engineer can inform you fully regarding the many quality advantages and cost-reducing possibilities that are obtainable with forgings.

DROP FORGING ASSOCIATION

Please send 60-page booklet entitled "Metal Quality—How Hot Working Improves Properties of Metals", 1949 Edition.

NAME_____

POSITION_____

COMPANY_____

ADDRESS_____

SALES AND SERVICE PERSONNEL

SEVERAL CHANGES in sales organization have recently been announced by Fairbanks, Morse & Co., Chicago. **J. A. Cuneo,** formerly branch manager in Los Angeles, has been transferred to Chicago to assume the duties of manager of that office. **John S. King,** former manager of the Chicago branch, has been moved to Cincinnati as branch house manager, succeeding **J. S. Peterson,** who has been transferred to the Chicago office. **William H. Kingsley** has joined the organization to become manager of the electrical division with headquarters in the company's executive offices in Chicago.

♦

Edgar T. Long has joined Reynolds Metals Co. as assistant product manager of the wire, rod, bar, and rolled shapes division. He will be located at general sales division headquarters, 2500 South Third St., Louisville, Ky.

♦

Janette Manufacturing Co., Chicago, builders of gearmotors and rotary converters, has announced the appointment of **W. H. SaLee** as general sales manager, succeeding **Harvey Klunder,** who recently resigned from the company. **Ogden J. Maag** will continue as assistant sales manager, and **Frank C. Hartmann,** who recently joined the company, will assist Mr. Maag.

♦

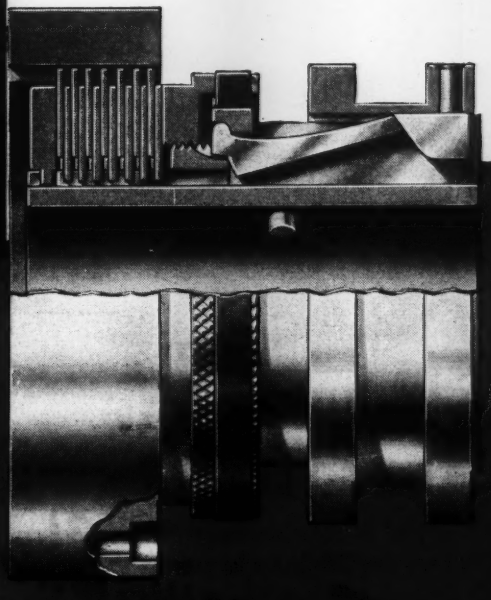
General sales engineer of Ampco Metal Inc., Milwaukee, **J. C. Kemp** has been appointed to the position of district manager of the company's Chicago office. Mr. Kemp was formerly sales engineer for Ampco in the Cleveland office. **R. J. Eckl,** former assistant general sales engineer, has assumed Mr. Kemp's position as general sales engineer.

♦

After an association of over forty-one years with the Garlock Packing Co., **Phil Arnold** has relinquished his duties and responsibilities in charge of the company's general sales department. He will, however, continue in a partially active capacity for an indefinite period as a vice president of the company, a position which he held since 1929. **Louis Mohn,** formerly district sales manager in Pittsburgh,

MAXITORQ

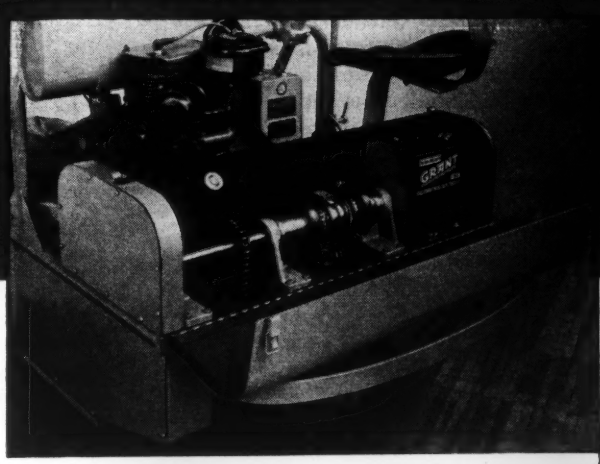
KEEPS GOOD COMPANY



The G. H. Tennant Co. has joined our "Good Company" roll by adopting a double Maxitorq multiple disc clutch as original equipment for its Industrial Power Sweeper, the first device of its type to have vacuum dust control. The installation controls forward and reverse direction of the machine and is also used as a brake.

They say, "Sweeper must be highly maneuverable, capable of short-radius turns, easy steering." *Maxitorq answers all three requirements.* Also, "Quick forward-reverse clutch action is needed to save time." *Maxitorq saves the time.* Again, "Smooth clutch action causes less wear on sweeper, makes it safer to operate, is less fatiguing on driver." *Three more O.K.'s for Maxitorq.* They also add, "It has lo[illegible] it's easy to adjust."

You might think [illegible] this customer are at least first [illegible] not the case. It's just an [illegible] from another satisfied [illegible] If you require dependable [illegible] within the capacity [illegible] (fractional to 15 H.P. [illegible] or dry, single or double) [illegible] send engineering data on [illegible]



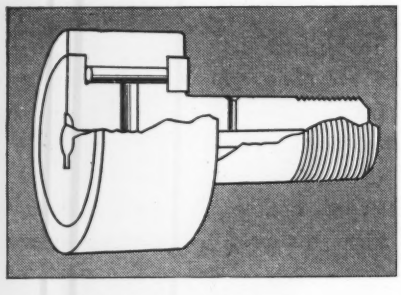
Send for Catalog MD2

THE CARLYLE JOHNSON MACHINE COMPANY

MANCHESTER • CONNECTICUT

McGILL DESIGN FOR CAM FOLLOWERS

Absorbs Excessive Shock Loads



You can see at a glance the ruggedness of construction which enables Multirol CF Series bearings to take repeated shock loads, even at the increased speeds demanded by modern machines. The extra heavy outer race section has a case hardened surface which provides extra wear, and a tougher core to resist shock loads. The inner race and flange, with hardened wear surfaces, are made of a single piece with the stud, preventing any possibility of disassembly in operation. Notice there are no delicate parts or washers anywhere, to break or cause trouble. The many full type small diameter rollers provide extra bearing surface. They are finished to precision limits assuring friction-free operation between the smooth ground raceways. Nearly twenty years successful operation in a variety of installations has proved the quality, construction and workmanship of CF Series Multirol bearings.

For installations where it is necessary to mount the bearing on a shaft, this same design is available in the Cam Yoke Roller (CYR) Series. For complete information about either type write McGill Mfg. Co., Inc., Bearing Division, 200 N. Campbell St., Valparaiso, Indiana. Ask for Bulletins CF-40 or CYR-47.

McGILL
TRADE MARK
precision bearings

has been appointed general sales manager with headquarters at Palmyra, N. Y., and **Eugene G. Flannery,** heretofore a Garlock sales representative in the Pittsburgh territory, has been named to succeed Mr. Mohn as district manager in Pittsburgh.

♦

P. F. Bauer, manager of Allis-Chalmers general machinery division's central region, has announced a change in status of the firm's Grand Rapids, Mich. office from branch to district office. **G. C. Culver,** who has been branch manager of the office since 1931, continues as district manager. Other changes in the region involve the transfer of **E. J. Kelley** from the Kansas City, Mo. district office to the Youngstown district office and the transfer of **T. E. Marchant** from the Youngstown office to the Pittsburgh district office.

♦

Recently associated with the Courier-Citizen Co. of Lowell, Mass., **John M. Gilbreth** has joined the New York staff of McKinsey & Co., management consultants. He has also served as an instructor in work simplification with the R. C. A. Victor division of the Radio Corp. of America and as a time-study engineer with the U. S. Rubber Co.

♦

L. A. Karg, formerly of Timken Roller Bearing Co., has been appointed sales manager of Tube Reducing Corp., Wallington, N. J. He worked as service engineer for Timken, concentrating on sales development work with particular reference to the application of tubing to the manufacture of screw machine parts.

♦

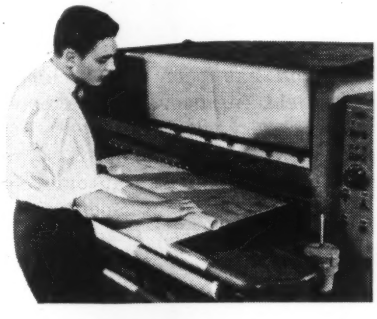
A former executive with Noma Electric Corp., **David Lewis** has been named general sales manager of the Lycoming-Spencer division of Avco Manufacturing Corp. In this newly-created position Mr. Lewis supervises sales of aircraft and industrial engines and related products, machine parts and gray iron castings produced by Lycoming-Spencer's two plants at Williamsport, Pa. His appointment is in line with a program to cover presently expanding business and the addition of new products.

♦

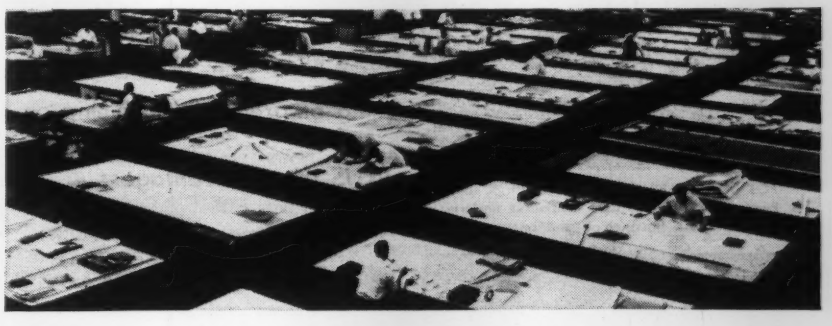
The appointment of **George S. Forbes** as manager of the Cleveland industrial sales division of the Glidden Co. was announced recently. He succeeds **Edward C. Shurtleff,** who has retired after forty-six years of service with the firm. Mr. Forbes joined

A $75,000 per year saving in the making . . .

Streaming off this continuous processing machine at the Ford Motor Company . . . are Kodagraph Autopositive prints—positive photographic intermediates of original drawings. *The answer to a $75,000 per year redrafting headache!*



Before . . . Ford's valuable original drawings had a short life . . . had to do double duty in the drafting room and in heavy print production. In the latter operation, they were exposed to machine wear and tear, constant handling. Soon they lost their detail . . . produced illegible blueprints . . . which meant that new drawings had to be ordered from the drafting room.



Now . . . Ford's originals are filed away in the drafting room after Kodagraph Autopositive intermediates are made—available for reference and revisions only! All blueprints are produced from the "Autopositives," whose photographic black lines will not smudge or lose opacity . . . assuring highly legible prints even after hundreds of "run throughs." As a result of this simple change in routine, *redrafting costs are reduced by an estimated $75,000 per year . . . while the output of creative drafting is increased.* And print production is simplified, too . . . for Kodagraph Autopositives are not only longer-lasting . . . but can be printed at uniform, practical machine speeds.

Kodagraph Autopositive Paper

"The Big New Plus" in engineering drawing reproduction

You, too, can cut your drafting costs, get improved legibility, and simplify print production . . . by reproducing your drawings on this new, low-cost photographic intermediate paper.

You can turn out "Autopositives" quickly, economically . . . with your present print-making equipment and standard photographic processing. Or else you can order them from your local blueprinter. *It will pay you to get all the facts soon!*

MAIL COUPON FOR FREE BOOKLET

EASTMAN KODAK COMPANY
Industrial Photographic Division
Rochester 4, N. Y.

19

GENTLEMEN: Please send me a copy of your illustrated booklet giving all the facts on Kodagraph Autopositive Paper.

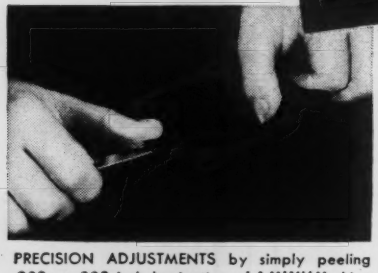
NAME_____ POSITION_____
(please print)

COMPANY_____ STREET_____

CITY_____ STATE_____

Kodak
TRADE-MARK

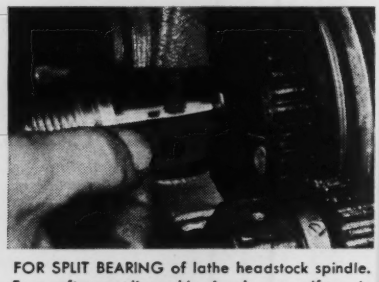
LAMINUM* Shims give .002 inch accuracy WITH AS MUCH AS .063 inch tolerance



PRECISION ADJUSTMENTS by simply peeling .002 or .003 inch laminations. *LAMINUM* shims available in thicknesses from .006 to .126 inch.

...cutting lathe costs ...saving assembly time

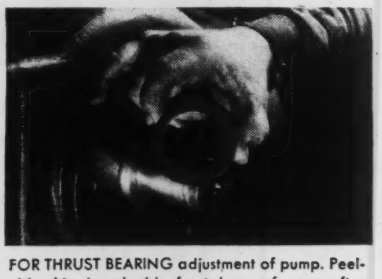
Use laminated shims, stamped from *LAMINUM*, to position machine elements accurately. With a .126 inch shim, made up of .002 inch laminations, for example, you have a full ⅛th inch of adjustment **built into** your assembly. There is NO filing or precision machining or grinding.



FOR SPLIT BEARING of lathe headstock spindle. Even after peeling, shim is always uniform in gauge, with a hard, clean and smooth surface.

PLUS these advantages:

- All adjustments AT THE JOB.
- No fumbling or counting loose shims.
- No dirt, oil, grease between shim layers.
- Less compressible than ordinary one-piece shims.
- No new skill required for use.
- Can be fitted with babbitted lugs to prevent oil and pressure loss.



FOR THRUST BEARING adjustment of pump. Peelable shim is valuable for takeup of wear after service, reducing "down time" for maintenance.

Send today for our new data file with specifications, design factors and applications. Sample of ***LAMINUM*** included.

SEE OUR CATALOG IN SWEETS FILE

STAMPING • GRINDING METALWORKING SERVICES

Press capacity to 100 tons, 24 inches square, shallow draw. Special equipment and variety of dies can eliminate die-making for short runs. Wide stock of materials. Let us quote on your *difficult* jobs.

* *LAMINUM* (Reg. U. S. Pat. Off.) shims are solidly bonded units made up of .002 or .003 inch brass or steel laminations with a microscopic layer of metallic binder. Cut to your exact specifications.

LAMINUM

THE SOLID SHIM THAT peels FOR ADJUSTMENT

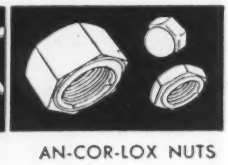
LAMINATED SHIM COMPANY, Inc.

1202 Union Street Glenbrook, Conn.

SHIMS

SHIM STOCK

STAMPINGS



AN-COR-LOX NUTS

the company in 1939, serving as a technical correspondent and later as assistant sales manager of the company's Reading, Pa. division. Upon his return from the Navy he was made industrial salesman in the Detroit territory and has been serving as Mr. Shurtleff's assistant since last July.

♦

With the territory of Colorado, Idaho, Montana, Utah and Wyoming, **David W. Jones Jr.**, Denver, Colo., will represent Lukens Steel Co. and its divisions, By-Products Steel Co. and Lukenweld, in the sale of steel plate and specialty plate products in the Rocky Mountain area. His territory, however, remains under the jurisdiction of Lukens Chicago district sales office.

♦

Manufacturers of control and protective devices, Spencer Thermostat division of Metals and Controls Corp. has appointed **C. A. Peterson**, formerly of the headquarters sales force, to take over the duties of field engineer in the St. Louis branch. Mr. Peterson succeeds **E. P. Jastram Jr.**, who has been made chief engineer. Field engineer for the newly-formed territory with headquarters in Dayton, O., is **B. O. Haun Jr.** Also, in addition to managing the automotive and aircraft section of Spencer Thermostat division, **Jerry Ottmar** has assumed the duties of sales promotion manager for the division.

♦

Sam Stroum, whose headquarters are at 2229 22nd Ave., North, Seattle, Wash., has been appointed sales representative for Clarostat Manufacturing Co. Inc., Dover, N. H. in the territory of Washington, Oregon, Idaho and Montana. Also, **W. H. Conner**, 1590 Eudora, Denver, Colo., has been named Clarostat representative for the states of Wyoming, Utah, Colorado and New Mexico.

♦

The following changes in plant management personnel have been announced by Link-Belt Co.: **Richard E. Whinrey**, now assistant general manager at the company's Dodge plant, Indianapolis, will assume the duties of assistant general manager at the Ewart plant, Indianapolis, on May 1, 1950. **Raymond S. Wood**, general manager at the Minneapolis plant, has been transferred to Indianapolis to replace Mr. Whinrey as assistant general manager at the Dodge plant. **Leslie J. Carson**, formerly chief engineer at San Francisco and at pres-

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

HOW LONG

will the Life-Line bearing last?

As long as comparable periodically lubricated bearings—or longer!

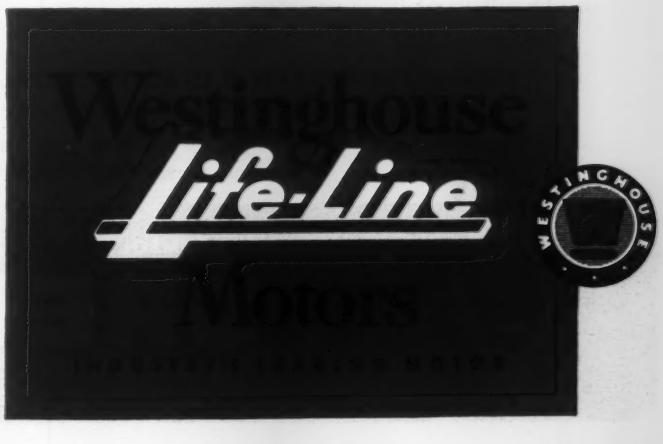
BEARING MANUFACTURERS SAY: "Pre-lubricated bearings have the same life expectancy as periodically lubricated bearings *IF those periodically lubricated bearings are perfectly maintained.*" But how often is a bearing perfectly maintained? Not often enough! That's why Life-Line pre-lubricated bearings offer fewer motor outages due to lubrication faults.

OPERATING RECORDS SAY: "41% fewer failures with Life-Line pre-lubricated bearings!" Life-Line motors placed in service throughout industry show a record of 41% fewer bearing failures than the best conventional motor (with conventional bearings) ever built by Westinghouse!

USERS SAY: "Life-Line bearings save me money." One motor user reports yearly lubrication costs of $3.06 per motor on ordinary motor bearings. An industry average indicates a yearly cost of $2.70 per motor a year. Multiply this by the hundreds of motors in your plant and you'll see why pre-lubricated Life-Line offers you an opportunity to cut life costs of motors. Life-Line needs no lubrication. You save this cost.

Get all the facts on Life-Line motors. See for yourself how much you can save. Ask your Westinghouse salesman for copies of "Facts on Pre-Lubricated Bearings," (B-4378) and "Motor Costs" (B-4321), or write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa.

J-21585



GREER ACCUMULATOR

Cuts Cost of This Machine $600.00, Reduces Its Weight 400 Lbs.

The accompanying illustration shows "The Bunell Completely Automatic Cylinder Trimming and Forming Machine" and two Greer Accumulators. The photograph is presented through the courtesy of the manufacturer, The Bunell Machine and Tool Co., Cleveland 14, Ohio.

"Using two 5-gallon Greer Accumulators in the hydraulic pumping unit of our completely Automatic Cylinder Trimming and Forming Machine we saved approximately $600.00 per unit cost and 50% of pumping unit floor space"— reports Mr. Victor S. Voigt, Chief Engineer and Sales Manager of the Bunell Machine and Tool Co. "The Greer Accumulators enabled us to use a smaller pumping unit thus making for a more compact and finer product with a saving of 400 lbs. in unit weight. In addition, using a simpler circuit we used fewer fittings and reduced maintenance to a minimum".

Redesigning your own process or machine to incorporate a Greer Accumulator, you too can cut unit cost, save floor space and increase production. Whichever way you use hydraulic power, a Greer Accumulator can help you do the job better, faster, more economically.

We at Greer are eager to discuss your particular hydraulic problem. A request for details on your company letterhead will bring an immediate reply. Write today.

SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

YOUR SYMBOL OF SERVICE

GREER

HYDRAULICS INC.

454 EIGHTEENTH ST., BROOKLYN 15, N. Y.

ent chief engineer at the Caldwell plant in Chicago, has moved to Minneapolis to assume the position of general manager of the Minneapolis plant and the north central sales division.

♦

Recently elected vice president of Hydraulic Equipment Co., Cleveland, **Ernest A. Berglund** has been active in the industrial hydraulics field for many years, and before joining Hydraulic Equipment Co. was manager of the hydraulics division of Commercial Shearing & Stamping Co. In his new capacity, Mr. Berglund will devote his attention to marketing and sales development.

♦

Located at 3435 Chouteau Ave., Indianapolis, Ind., **James Kress** is now St. Louis area representative for the R-B-M division of the Essex Wire Corp., manufacturers of manual and magnetic electrical controls for automotive and industrial application. R-B-M has also opened a new office at 5219 Crittenden Ave., Indianapolis, Ind., under the direction of **P. C. Metsker.** Mr. Metsker was formerly in the Detroit office and has been replaced there by **Ed Easley.**

♦

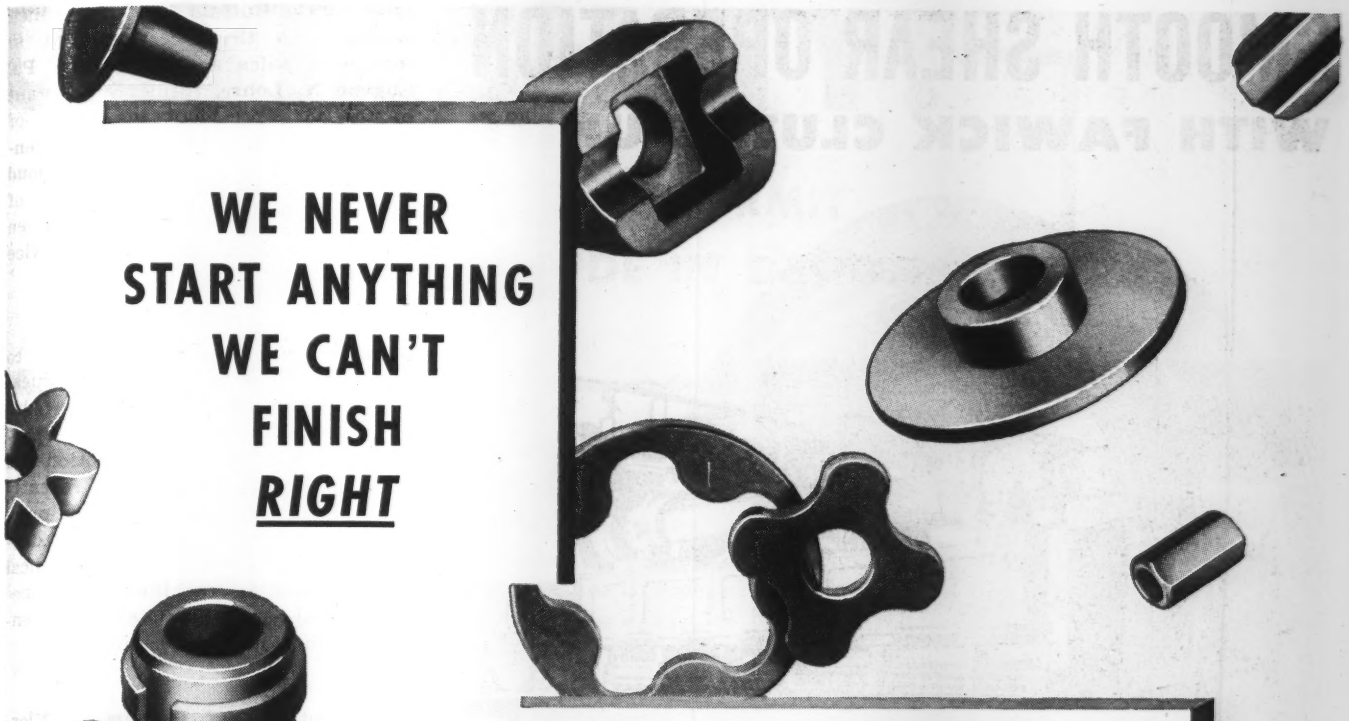
Formerly district engineer in Texas, **Harold Duncan** has been promoted to the position of assistant regional manager and has been placed in charge of a group of district engineers for Eutectic Welding Alloys Corp. of New York. Serving users of Eutectic products throughout the Southwest, offices of the company are located at 3852 Turtle Creek Drive, Dallas, Texas, and at 1213 Capital Ave., Houston, Tex.

♦

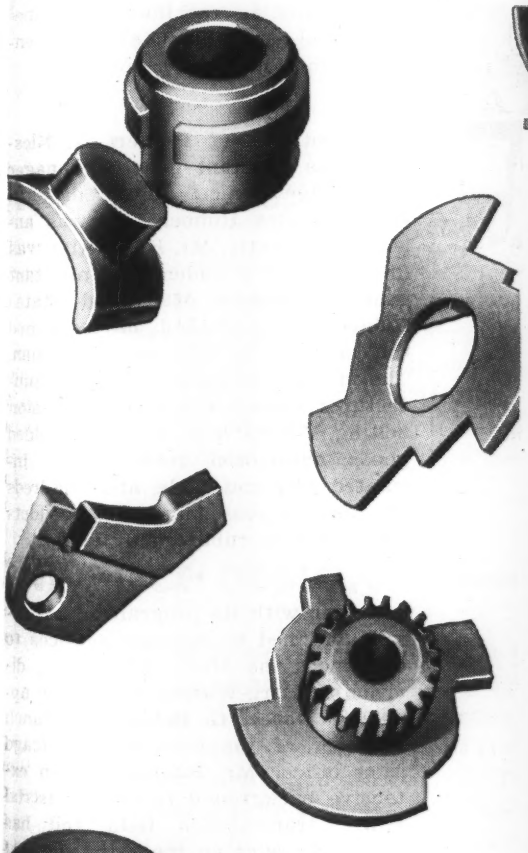
Announced recently was the appointment of **Walter E. McArthur,** former Eastern regional manager of the Nelson Stud Welding division of Morton Gregory Corp., as manager of industrial sales. In his newly-created position, Mr. McArthur will co-ordinate stud welding sales and engineering service to large national firms having engineering and purchasing departments in various locations.

♦

The Jessop Steel Co., Washington, Pa., has named **Charles E. Rice** to the position of general manager of sales. He had been manager of sales for the Pittsburgh territory and is being replaced by **E. H. Dau,** who joined the company in 1943 as special representative for stainless and stainless-clad steels, becoming manager of

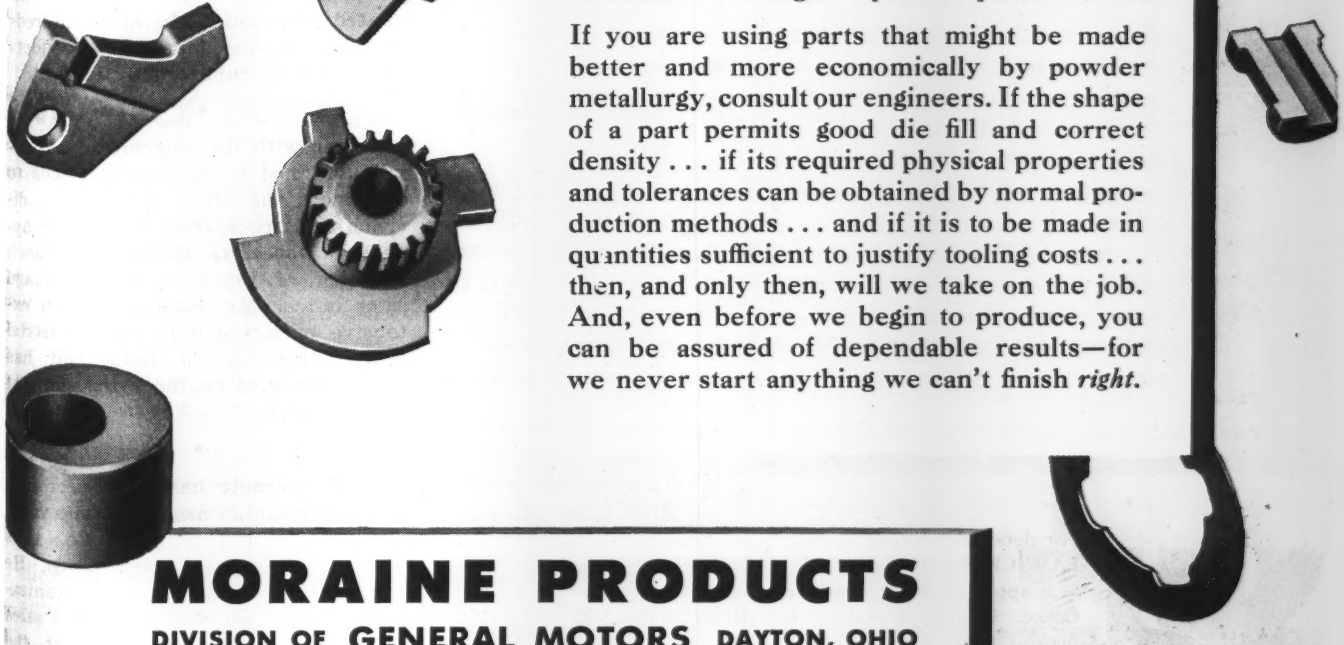


WE NEVER START ANYTHING WE CAN'T FINISH *RIGHT*



It has always been Moraine's policy to turn down orders for metal powder parts unless we are positively sure that the powder metallurgy process will work to the advantage of the purchaser. That policy is paying off, too. It brings us inquiries from prospective customers who know that, if we *do* undertake their work, they will benefit through savings in costs or through improved performance.

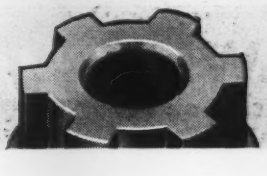
If you are using parts that might be made better and more economically by powder metallurgy, consult our engineers. If the shape of a part permits good die fill and correct density . . . if its required physical properties and tolerances can be obtained by normal production methods . . . and if it is to be made in quantities sufficient to justify tooling costs . . . then, and only then, will we take on the job. And, even before we begin to produce, you can be assured of dependable results—for we never start anything we can't finish *right.*



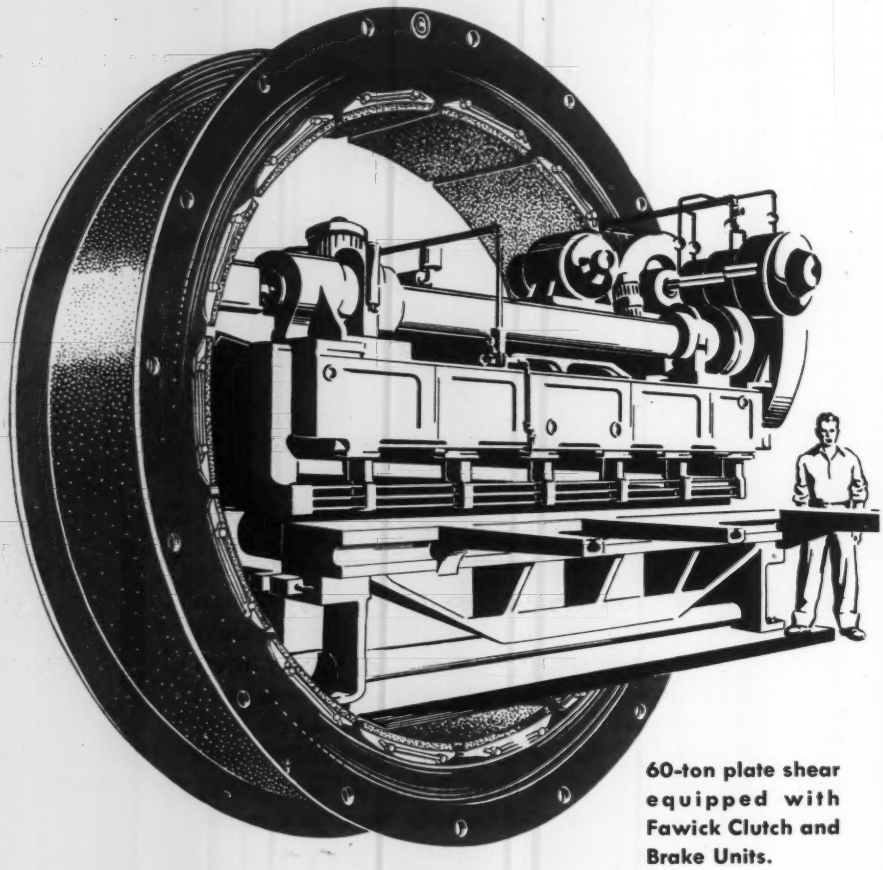
MORAINE PRODUCTS

DIVISION OF **GENERAL MOTORS** DAYTON, OHIO

METAL POWDER PARTS BY MORAINE



SMOOTH SHEAR OPERATION
WITH FAWICK CLUTCH UNITS



60-ton plate shear equipped with Fawick Clutch and Brake Units.

Smooth power is needed for fast operation and clean shear jobs in plate work. FULL power is needed for the tough thick jobs.

Fawick Airflex Clutches not only supply smoothness and full power but also eliminate periodic "downtime" for lubrication or clutch adjustment to compensate for wear.

All press and shear conversions to Fawick Clutches are paying profit dividends to users.

For detailed information on the advantages of the FAWICK PACKAGE-UNIT CONVERSION plan as it applies to your equipment, write to the Main Office, Cleveland, Ohio, for BULLETIN 900.

All desirable clutch characteristics are built into Fawick Airflex units

FAWICK Airflex CO., INC.

sales for the Buffalo district and then assistant to the vice president in charge of sales at Washington, Pa. **Eugene N. Lohre,** formerly assistant to the vice president in charge of sales, was appointed assistant general manager of sales, and **Raymond R. Huffman,** previously manager of the service-sales department, has been made assistant to the executive vice president.

♦

Recently appointed assistant to **Scott D. Baumer,** manager, technical sales division of Air Reduction Sales Co., **J. H. Berryman** will be responsible for the technical promotion and sales of equipment for the recently introduced Aircomatic welding process. Mr. Berryman joined Air Reduction in 1946, serving in the technical sales division as machine welding specialist and assistant metallurgical engineer until his recent promotion.

♦

Appointment of **Herbert G. Kieswetter** as assistant general manager of the mechanical goods division, United States Rubber Co., was announced recently. Mr. Kieswetter was formerly vice president and assistant general manager of United States Rubber Export Co. Ltd., having joined the company in 1925 as a salesman. The mechanical goods division manufactures conveyor and transmission belting, V-belts, hose, packing, molded goods, automotive rubber parts, insulated wire and cable, and hundreds of miscellaneous industrial products made of both rubber and plastic.

♦

In line with its program of expansion designed to increase services to customers the Morse Chain Co., division of Borg-Warner Corp., has appointed **Robert G. Holmes** as branch manager of the company's Chicago sales office. Mr. Holmes has an extensive background in the industrial power transmission field and has served as sales engineer for the last twelve years.

♦

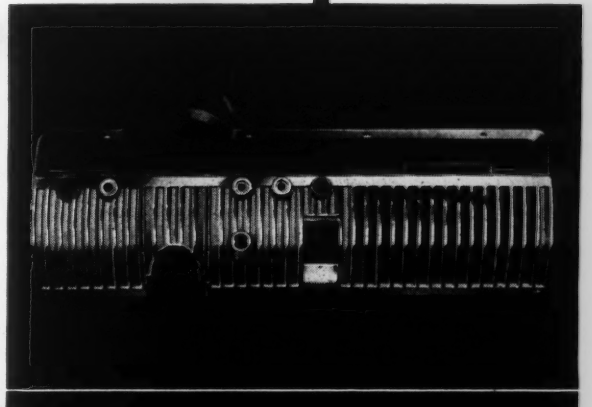
R. E. Barnett has been promoted to the position of assistant sales manager of Marsh Instrument Co., sales affiliate of Jas. P. Marsh Corp. He has been with the Marsh organization for the past nine years in a sales capacity with headquarters at the company's home office in Skokie, Ill. Among his new duties, Mr. Barnett will work in close contact with the company's nation-wide sales organization to promote and maintain maximum co-ordination with the home office.

CASTABILITY!

ZINC DIE CASTINGS PERMIT GREATEST LATITUDE IN DESIGN

EASE OF CASTING

For proof of the unusual castability of ZINC die casting alloys you need only examine the instrument panel of the 1950 Mercury. This ZINC die casting, beautifully finished in a combination of plating and paint, is an outstanding example of the latitude in design offered to engineers by the "ease of casting" characteristics of ZINC alloys.



LESS METAL USED

Here the casting is shown from the reverse side to reveal the complex coring which minimizes the amount of metal consumed—without affecting the illusion of massive construction. The castability of the ZINC alloy enables transition from thick to thin sections, and facilitates complex shapes, close dimensional limits and surface smoothness.

ONE-PIECE DESIGN

As can be seen in this view of the instrument panel casting on the car, it not only includes the radio grille, it also serves as the frame for the various instruments, operating controls (including the radio pushbuttons), and ash receiver. The names of the various controls are engraved on the casting and all assembly elements are provided on the panel as it comes from the die.

The exceptional castability of ZINC Alloys is just one of the many reasons why ZINC die castings are the most widely used. Every die casting company is equipped to make ZINC die castings and will be glad to discuss their advantages with you. Or write to us.

ZINC
FOR DIE CASTING ALLOYS

The New Jersey Zinc Company, 160 Front Street, New York 7, New York.

The Research was done, the Alloys were developed, and most Die Castings are based on

HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

No Imperfections!

USE SUPERIOR FOR DIESEL FUEL INJECTION TUBING

A sample six-inch length of this diesel fuel injection tubing will be sent upon request on your company letterhead.

Superior cold drawing processes limit seams, laps, pits and slivers to the absolute attainable minimum—for fuel injection tubing with its highly critical operating pressures and endurance requirements the finishes of the tubing must be flawless—must have uniform, clean surfaces.

Close production and laboratory control, selection of raw stock billets, microscopic inspection of material in process and at finish, exact furnace atmospheric and temperature control, these are the Superior procedures that assure clean, bright, dead soft tubing.

Superior tubing is cold drawn to customer specifications, no "standard" sizes are carried in mill stock. Available in random, multiple or cut lengths, to American Bosch or your specifications, this fuel injection tubing is bound to do a better job.

We invite your request for further information.

Superior

THE BIG NAME IN SMALL TUBING

SUPERIOR TUBE COMPANY

2010 Germantown Ave., Norristown, Pa.

For Superior Tubing on the West Coast, call PACIFIC TUBE CO., 5710 Smithway St., Los Angeles 22, Cal. • ANgelus 2-2151

SALES NOTES

OPERATING as a branch of the company's Buffalo office, a new sales office at Syracuse, N. Y. has been opened by **Cutler-Hammer Inc.**, Milwaukee. The new branch, located in the State Tower Bldg., 109 South Warren St., has been assigned to cover the firm's accounts in the eastern half of the Buffalo district.

♦

The appointment of **J. A. Shomer Co.**, 11201 Berea Road, Cleveland 2, O., as distributors in the Cleveland area has been announced by **Morse Chain Co.**, division of **Borg-Warner Corp.** of Chicago. The Shomer Co. specializes in power transmission equipment, and the addition of Morse products to their present lines will offer their customers a complete source of supply for equipment of this type.

♦

The **Richmond Welding Supply Co.**, Richmond, Va., has been appointed an authorized dealer for **Air Reduction Sales Co.** and will carry a complete line of Airco gas and electric arc welding equipment supplies and accessories.

♦

Expanding its warehouse facilities in the Philadelphia area, the **Fafnir Bearing Co.** of New Britain, Conn., has acquired a building at 4006 York Road, Philadelphia, Pa. The structure houses Fafnir's branch office and warehouse stock, providing several times the area available in the company's former location.

♦

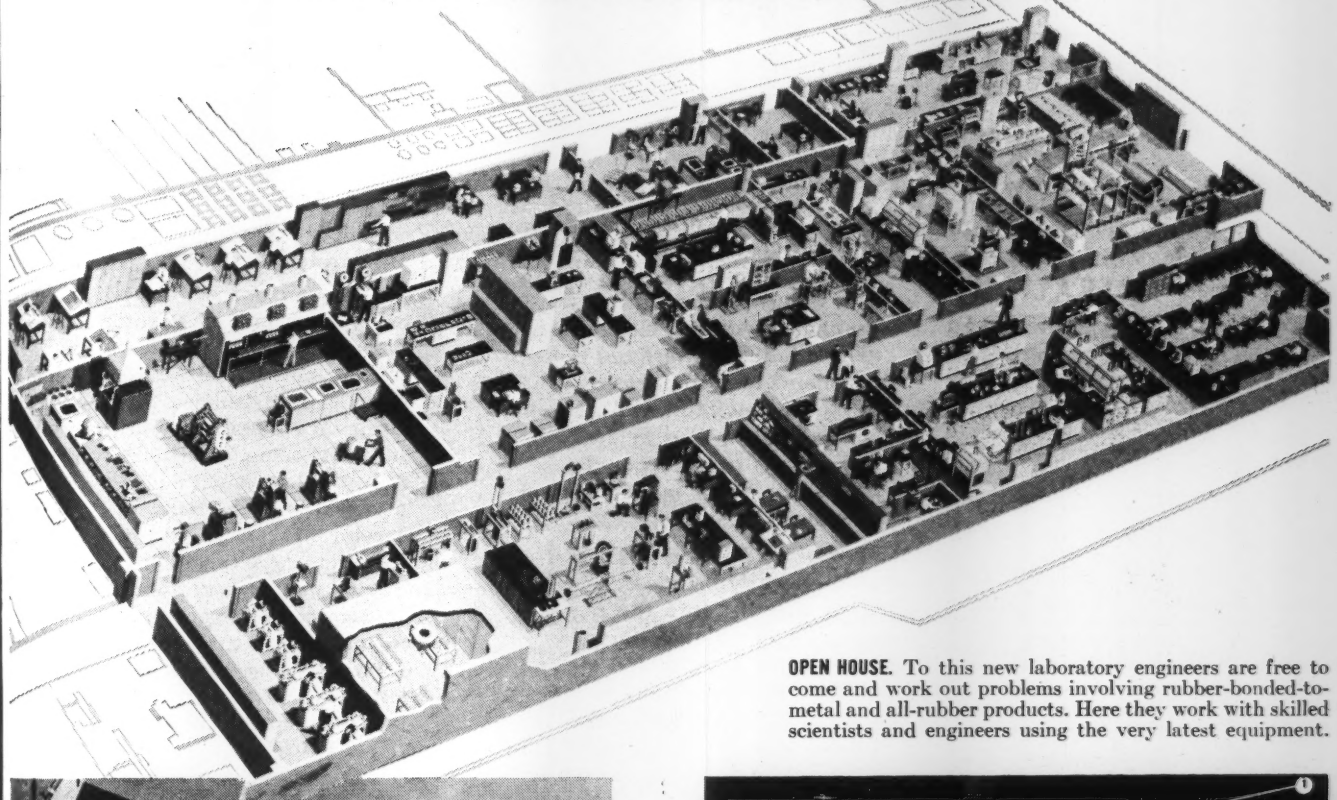
Selas Corp. of America has announced that their Chicago office is now located at 3857 West Washington Blvd., Chicago 24, Ill.

♦

Construction of a large brick and steel addition, approximately 118,000 square feet, to the Chicago plant of **Joseph T. Ryerson & Son Inc.**, steel distributors, has been completed. The addition is located at Fifteenth and Rockwell Streets and forms a part of the north unit of the company's six-block long plant. It is used principally to warehouse bar and sheet

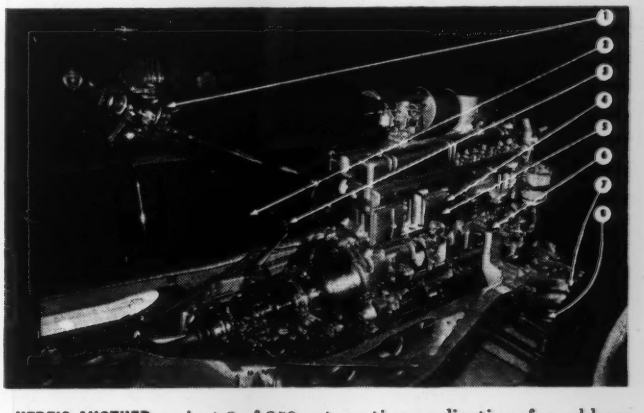
TREASURE HOUSE OF SCIENCE

Harmful vibration and noise in mechanical equipment eliminated in U. S. Rubber Laboratories, Ft. Wayne



OPEN HOUSE. To this new laboratory engineers are free to come and work out problems involving rubber-bonded-to-metal and all-rubber products. Here they work with skilled scientists and engineers using the very latest equipment.

ONE WAY IT PAYS OFF . . . a new "U. S." rubber Evener Bearing Assembly developed jointly at Ft. Wayne for this oil well pumping unit. Its simplified design eliminates 62 parts. Maximum shock protection allows 200% longer wear.



HERE'S ANOTHER . . . just 8 of 350 automotive applications for rubber parts developed in the Ft. Wayne Laboratory: 1) steering wheel. 2) brake lever pedal pad. 3) brake lever seal. 4) ignition wire. 5) ignition wire ferrules. 6) front engine mounting. 7) control arm rebound bumper. 8) spring bumper.

Are you concerned with reducing noise, vibration, shock in mechanical equipment . . . with reducing strain on individual metal parts? If so, U. S. Rubber Engineers invite you to work out your problems with them in their Ft. Wayne Laboratory —control center for the world's most modern Engineered Rubber Products Plant. Send for your copy of the new informative booklet, "This Is Your Laboratory." Write to Engineered Rubber Products Division,

A DEVELOPMENT OF

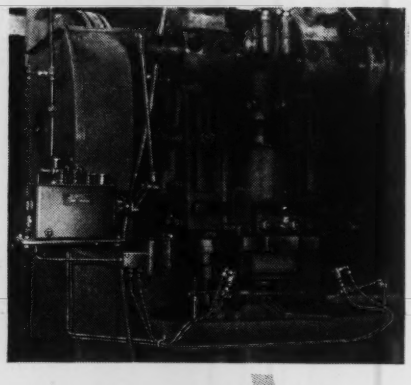
U.S.RUBBER
SERVING THROUGH SCIENCE

UNITED STATES RUBBER COMPANY

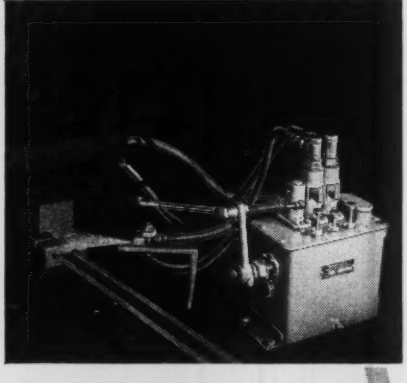
ROCKEFELLER CENTER, NEW YORK . . N. Y.

CUT 'DOWN TIME'... INCREASE PRODUCTION... REDUCE OPERATING COSTS...

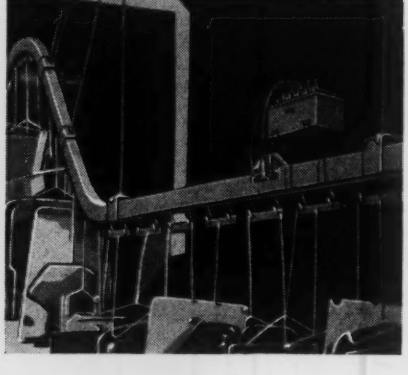
IN PRESS OPERATIONS



IN SHEAR OPERATIONS



IN CONVEYOR SYSTEMS



Dies, punches, and shear knives wear up to three times as long! Only 1/10 as much oil now being consumed! Punch breakage reduced, oil drippage eliminated! . . . These are typical comments of manufacturers using the new Manzel Automatic Spray System. And in every case the savings are out of all proportion to the modest cost of installing the system.

Manzel Spray Lubricators force automatically timed jets of oil spray directly onto the punches, shear knives, dies, rollers, or other parts. Compressed air and oil are fed simultaneously into a spray nozzle aimed at the critical area. The system is readily installed on any type of equipment, large or small. Write today for descriptive folder.

Manzel engineers will gladly assist you in solving any lubrication problems.

WITH MANZEL SPRAY LUBRICATION

Manzel

DIVISION OF
FRONTIER INDUSTRIES, *Inc.*
276 BABCOCK STREET, BUFFALO 10, N. Y.

steel and tubular products. The Ryerson Co. has also begun construction of a new and large steel service plant and office building at Spring Grove Ave. and Adelaide St. in Cincinnati. Designed to provide larger and more complete stocks of steel and faster service for the Cincinnati marketing area, the plant is scheduled to be completed by fall of this year.

♦

Ampco Metal Inc., Milwaukee, has announced the appointment of **Southern Engine and Pump Co.,** Houston, Tex., as distributor of the Ampco centrifugal pump line.

♦

Rivett Lathe & Grinder Inc., Boston, has announced the purchase of the entire line of Gerotor air and hydraulic valves, cylinders and hydraulic power units from **Gerotor May Corp.,** Baltimore. All manufacturing and selling operations of the line are being transferred immediately to Boston with no interruption in acceptance and delivery of orders. Gerotor May Corp. is retaining the manufacture and sale of Gerotor hydraulic pumps and fluid motors at Baltimore. The new Rivett line will be marketed through the present Gerotor dealer organization, which will continue to handle Gerotor hydraulic pumps and fluid motors.

♦

A new sales office at 2620 Maury St., Houston, Tex., has been opened by **American Brake Shoe Co.** to provide more direct service to customers in the Southwest territory. Wiliam C. George, who has been appointed sales engineer for the company in this territory, will represent the company's American Manganese Steel, Electro-Alloys and National Bearing divisions. His activities will center in Oklahoma, Texas, and Louisiana.

♦

It was announced recently that the **Nice Ball Bearing Co.** has moved to 137 South 52nd St., Philadelphia 39, Pa.

♦

The **Dow Chemical Co.** has announced the appointment of **Reliance Steel Co.,** 2068 East 37th St., Los Angeles, Calif., to warehouse magnesium wrought products. This move, Dow's first venture into warehousing of magnesium, is expected to be the forerunner of a nation-wide service. Initially, Reliance Steel Co. will warehouse a limited supply of typical extruded rods, bars, and shapes, other wrought products being added to this stock as they become available.

Three things every maker of hollow cylindrical parts should know about TIMKEN® tubing

1. *Eliminates drilling, saves time and material*

You're half through before you start when you make cylindrical parts from Timken® seamless steel tubing instead of bar stock. Timken seamless tubing cuts time and cost because it eliminates drilling, reduces boring, saves scrap and permits faster machining speeds. Finish boring is often your first production step.

2. *Most economical size assured by our tube engineering service*

Our tube engineering service makes even greater savings possible because our engineers choose the most economical size tube for you . . . and it's guaranteed to clean up to exacting finished dimensions. This tube engineering service is recognized and proved. That's why 90% of Timken tubing is bought on this basis.

3. *Superior forged quality improves the finished product*

Timken seamless tubing is made by a process that is basically a forging operation. Red hot billets are forced over piercing points by rolls that work the steel with a kneading, spiral action, giving Timken tubes uniform, spiral grain flow and refined grain structure. And foot-a-second piercing stops heat loss, assures uniform quality from one end to the other. Why not get the complete story on Timken tubing from our Technical Staff? Also ask for a free copy of our informative, 68-page booklet, "Facilities and Products". Write The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

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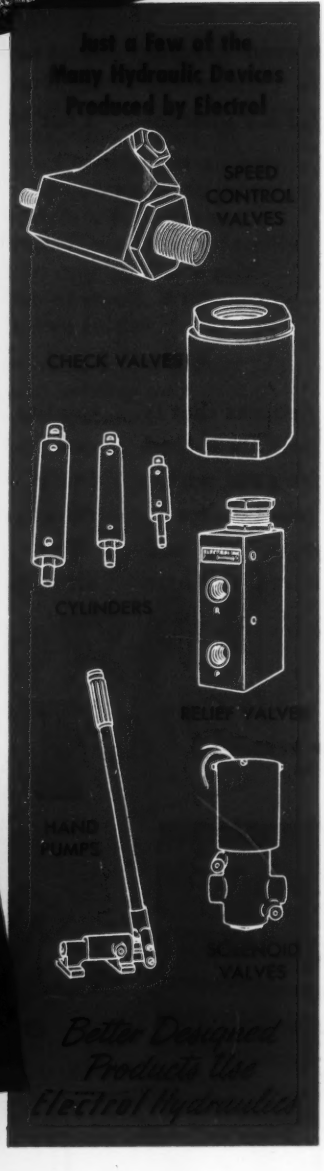
Probabilities are, too, that through availing yourself of the experience we have gained—in the development and production of countless hydraulic components and assemblies—you will find many ways to cut time, labor and cost.

Your inquiry will receive prompt attention.



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MEETINGS AND EXPOSITIONS

Feb. 12-16—

American Institute of Mining & Metallurgical Engineers. Annual meeting of the Iron and Steel Division, the Institute of Metals Division and the Extractive Metallurgy Division in connection with general meeting of AIME to be held at the Hotel Statler, New York, N. Y. Ernest Kirkendall, 29 West 39th St., New York 18, N. Y., is secretary.

Feb. 27-Mar. 3—

American Society for Testing Materials. Spring meeting to be held at the Hotel William Penn, Pittsburgh, Pa. Robert J. Painter, 1916 Race St., Philadelphia 3, Pa., is assistant to the secretary.

Mar. 14-16—

Society of Automotive Engineers. Passenger car, body and production meeting to be held at the Book-Cadillac Hotel, Detroit, Mich. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

Mar. 28-31—

Society of the Plastics Industry. Fourth national plastics exposition to be held at the Navy Pier, Chicago, Ill. William T. Cruse, 295 Madison Ave., New York 17, N. Y., is executive vice president.

Apr. 4-8—

National Production Exposition sponsored by the Chicago Technical Societies Council will be held at the Stevens Hotel, Chicago, Ill. John C. Toohy, 176 W. Adams St., Chicago 3, Ill., is exhibit manager.

Apr. 10-14—

American Society of Tool Engineers. Industrial exposition to be held at Convention Hall, Philadelphia, Pa. Additional information and advance registration forms may be obtained from Harry E. Conrad, executive secretary, 10700 Puritas Ave., Detroit 26, Mich.

Apr. 17-19—

Society of Automotive Engineers. Aeronautic meeting and aircraft engineering display to be held at the Statler Hotel, New York, N. Y. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

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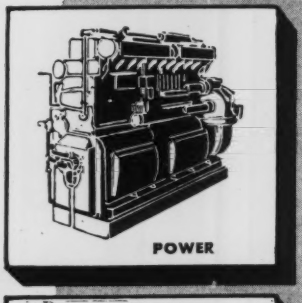

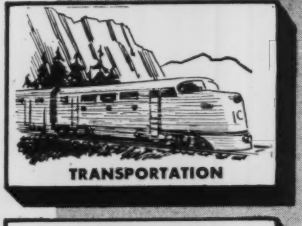

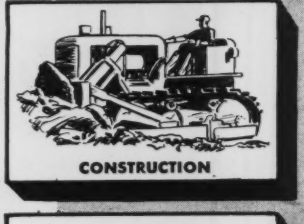

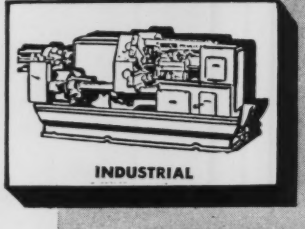

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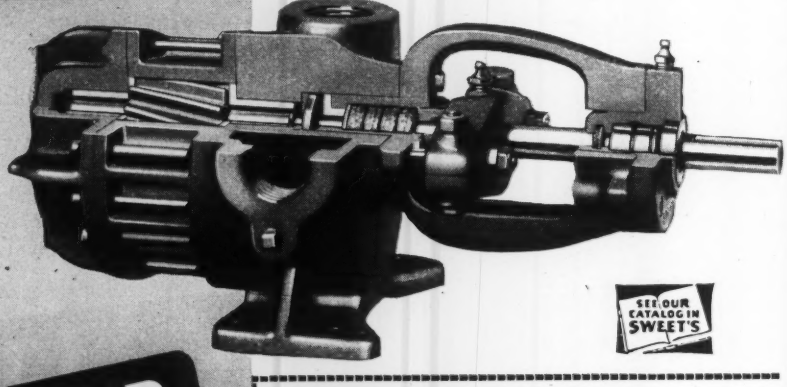

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April 24-27—

American Management Association. 19th national packaging exposition to be held at the Navy Pier, Chicago, Ill. Edward K. Moss, 330 West 42nd St., New York 18, N. Y., is public relations director.

Apr. 25-26—

Metal Powder Association. Sixth annual meeting to be held at the Book-Cadillac Hotel, Detroit, Mich. Additional information may be obtained from headquarters of the society at 420 Lexington Ave., New York 17, N. Y.

May 8-12—

American Textile Machinery Exhibition to be held in Atlantic City Auditorium, Atlantic City, N. J., under the sponsorship of the National Association of Textile Machinery Manufacturers. E. Kent Swift, Whitinsville, Mass., is president.

May 8-19—

British Industries Fair to be held at Olympia and Earls Court, London; and at Castle Bromwich, Birmingham, England. Additional information may be obtained from British Information Services, 30 Rockefeller Plaza, New York 20, N. Y.

May 29-June 9—

Canadian International Trade Fair to be held at Toronto, Canada. Additional information may be obtained from the International Trade Fair, Exhibition Grounds, Toronto, Canada.

June 4-9—

Society of Automotive Engineers. Summer meeting to be held at French Lick Springs Hotel, French Lick, Ind. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

June 11-16—

American Electroplaters' Society. 37th annual convention to be held at Hotel Statler, Boston, Mass. Fourth International Electrodeposition Conference in collaboration with the Electrodepositors' Technical Society of England to be held concurrently. Additional information is obtainable from American Electroplaters' Society, 473 York Rd., Jenkintown, Pa.

June 26-30—

American Society for Testing Materials. 53rd annual meeting and ninth exhibit of testing apparatus and related equipment to be held at Chalfonte-Haddon Hall, Atlantic City, N. J. Robert J. Painter, 1916 Race St., Philadelphia 3, Pa., is assistant to the secretary.

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DESIGN ABSTRACTS

Production Expedited Through Subassemblies

ONE of the most effective means of streamlining engine production is to arrange the parts in such a manner that the unit can be broken down into a number of individual subassemblies. Planning engine design and manufacturing deliberately to make full use of subassembly procedures results in many advantages affecting facilities required, subcontracting operations, quality control, overhaul activities, etc. Among the advantages are:

1. Subassemblies can be manufactured, inspected and put together by persons who have become skilled on those particular operations. Components such as the accessory gearbox, fabricated sheet-metal portions and bladed rotors require different skills. By dealing with these components separately, it becomes possible to specialize. Operators can be trained in a shorter time.

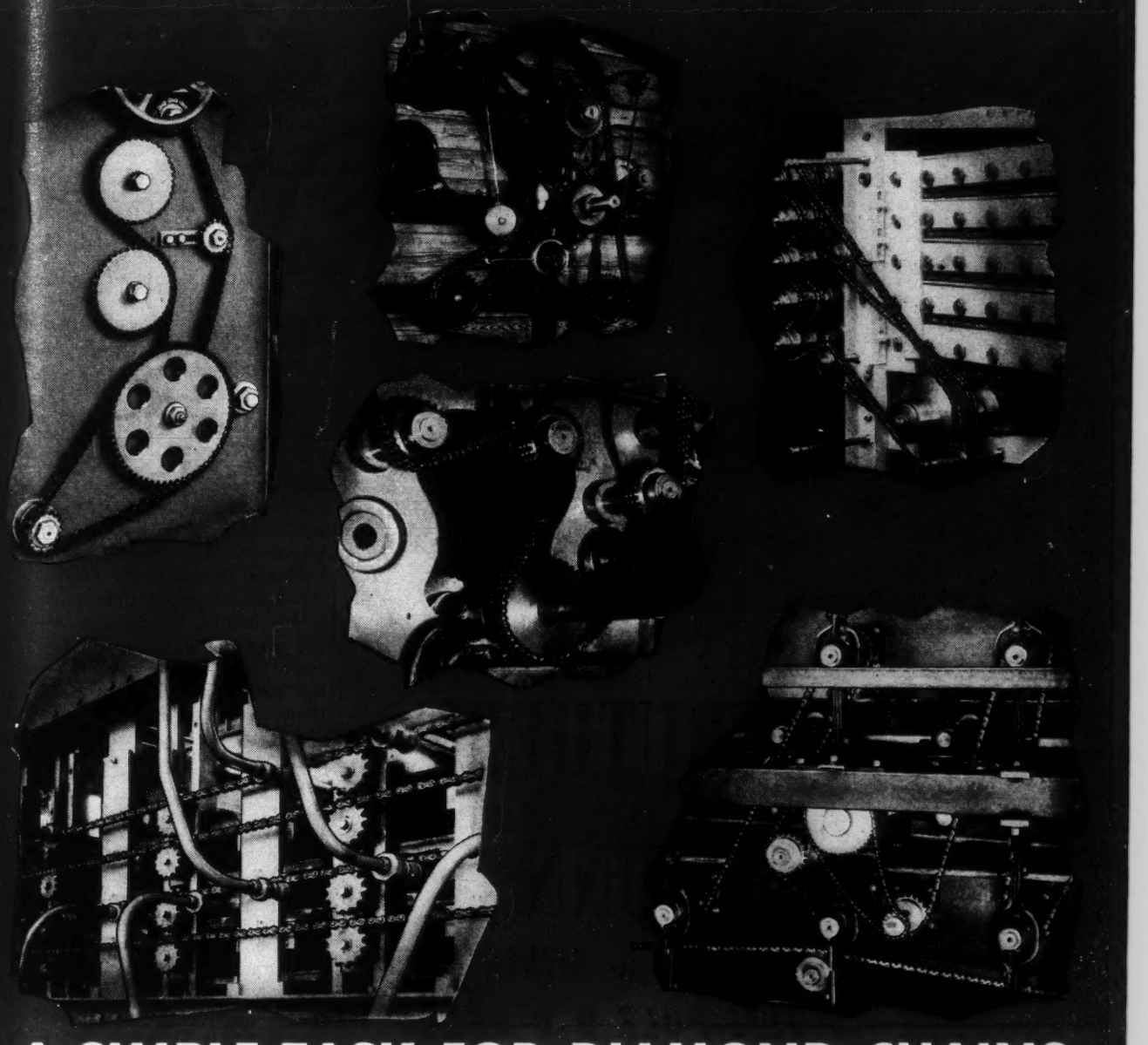
2. Subassembly operation permits subcontracting to many qualified concerns. By breaking down the engine into suitable subassemblies, these can be manufactured separately by firms that are equipped and have experience in the production of weldments, gears, blades, etc. Where production in large quantities is desired, this offers the possibility to spread out the work among a larger number of organizations.

3. Use of subassemblies results in a short, orderly assembly line. A cushioning effect is obtained by feeding in subassemblies from stores. Possible difficulties encountered in a subassembly often can be ironed out without disrupting the main assembly line. Subassemblies can be tested or checked individually to insure proper functioning prior to assembly into the complete unit.

In addition to being able to trace errors quicker, time is saved also in not having to tear down the whole engine to correct or replace an offending part. For example, leaks can be discovered on individual components which can be adjusted without disturbing the main assembly. Naturally, subassemblies can be designed to be built up in turn from subassemblies which lend themselves to orderly manufacture and inspection.

4. Well-planned subassemblies benefit overall as well as initial production. Many of the operations per-

DRIVING MANY SHAFTS FROM ONE SOURCE



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formed during assembly and disassembly of the engine before shipment recur in the field while overhauling and inspecting the engine. Therefore, the user of the engine derives distinct benefits from a design that permits easy assembly and checking of individual components. *From a paper by R. P. Kroon and F. D. Bergvall, aviation gas turbine division, Westinghouse Electric Corp., presented at SAE National Aeronautic meeting in Los Angeles.*

Designing For Manufacturing Economy

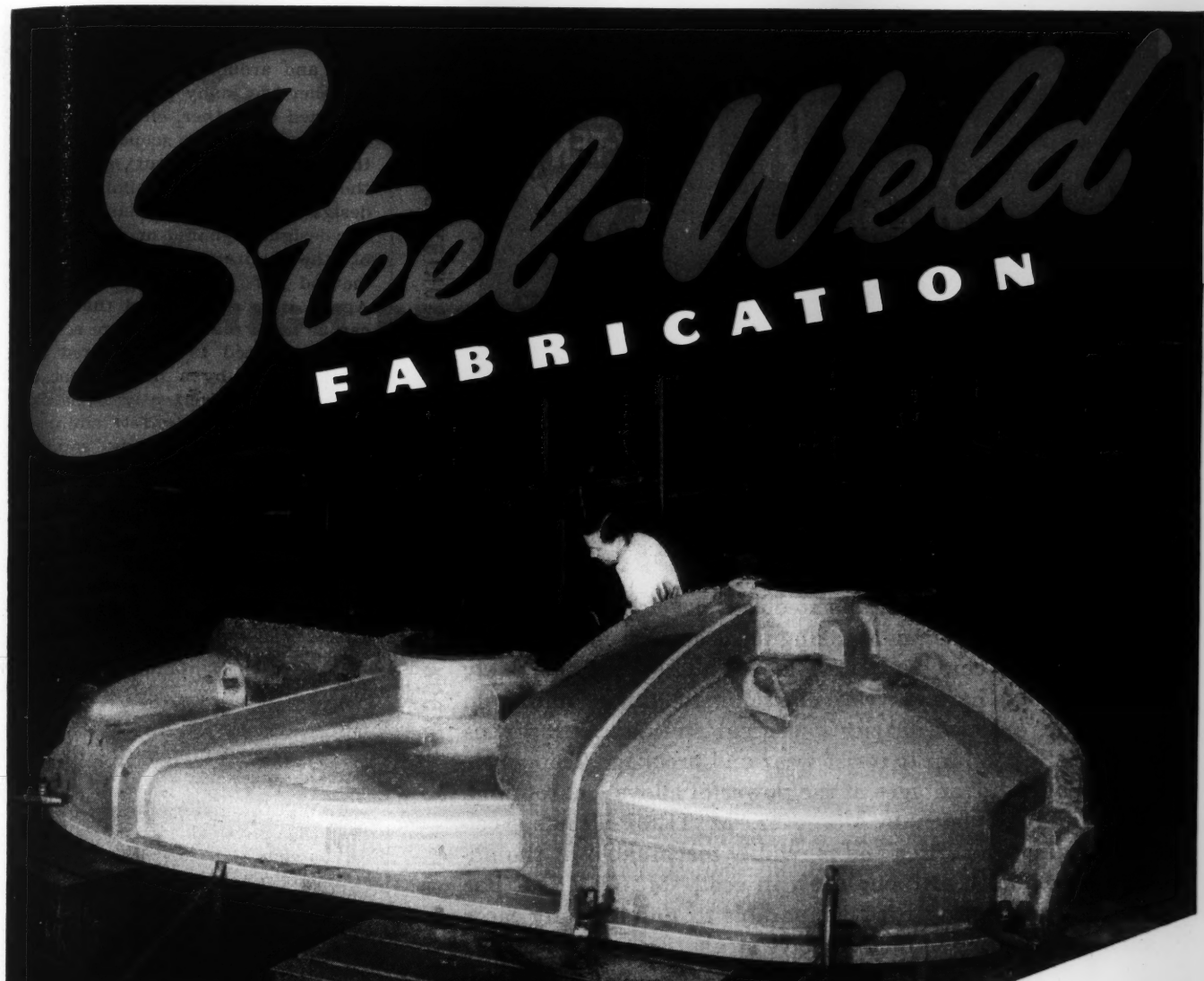
BEFORE the designer there lie two broad fields which might be termed generally, "functional design" and "production design." Functional design may be looked upon as the conception and development of an idea into a product, mechanism, or machine which will perform a specific function. Normally the primary aim is to achieve a design which will accomplish the desired purpose, will function satisfactorily and will meet the necessary practical performance requirements. Production design, on the other hand, directly follows functional design and comprises basically the study and redesign of the functional parts to simplify manufacture —in one sense a process of fitting the parts for the simplest, most rapid method of manufacture.

Careful designing for production can achieve a variety of substantial economies in manufacture, a factor all too often overlooked. The tendency to ignore or to forget the broad limitations inherently present in all processing methods is ever-present. The number of products and machine parts which, as originally designed, are impossible or excessively costly to process is amazing. The point has been made many times but it should always be remembered that a mechanism which is impractical to manufacture is just as much an indication of poor design as a mechanism which will not function or perform properly.

Process Knowledge Required

Economical and thoroughly practical production design of machine parts must be based to a great extent upon a wide knowledge of the various basic methods employed in manufacture. By concentrating on basic operations available through the readily tooled and adapted production methods rather than solely on the product or part to be made, maximum economy, flexibility, accuracy, and speed in manufacture can be realized. Although this may seem a long step in a new direction in some

Steel-Weld FABRICATION



Steel-Weld Fabrication of irregular shapes, such as the gear housing cover illustrated above, is a true test of design ability, craftsmanship and production facilities. Regardless of what your requirements may be — no matter what size, shape or weight — you will find in the Mahon organization an unusual source for welded steel in any form . . . a source with complete production and machining facilities, backed by a staff of competent design engineers and highly skilled workmen from whom you may expect a smoother, finer appearing job, embodying every advantage of Steel-Weld Fabrication.

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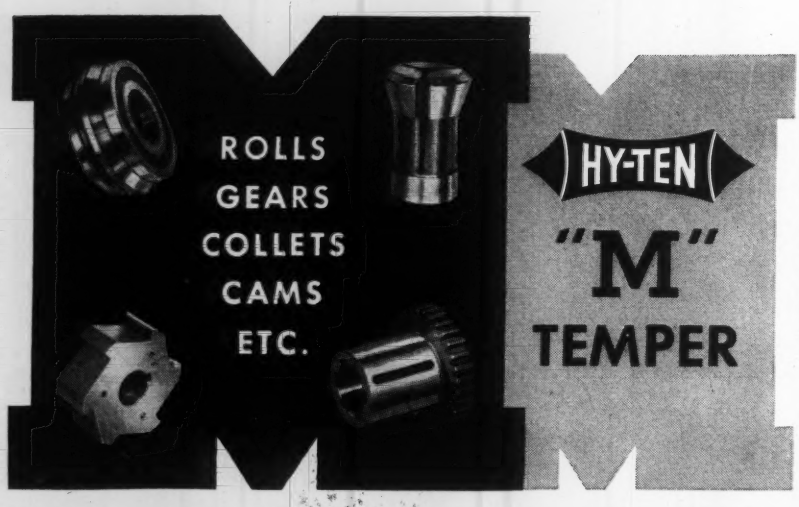

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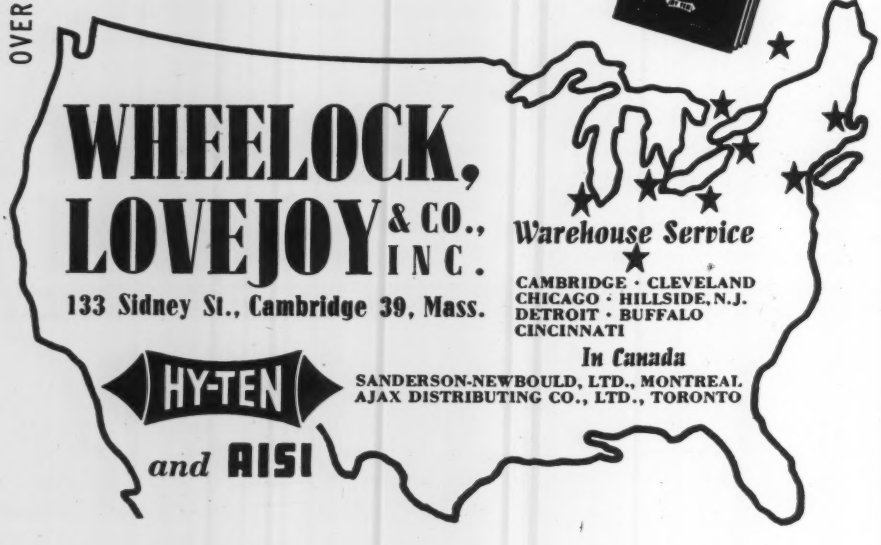

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respects, for the most part, it is actually only the elimination of the long and arduous path by which altogether too many parts must be redesigned or, rather, changed to bring them back into the scope of economy through a round-about means from the shop, production planning, or tool-design department primarily because the designer ignored or was unaware of the limitations present in the method of processing necessary. Again, it is often found that a part can be more readily or more economically produced to the desired basic specifications by a method not considered or inadvertently overlooked; and this with but a few simple design changes. Achieving minimum cost of production for a specific design and also maximum value from the least amount of material, requires high output per hour, low tooling costs, minimum setup time, and the like. It also means simplicity of physical design features, and proper evaluation and consideration of all possible methods by which the part can be made.

All too often, design of a particular component is carried out arbitrarily without first raising these important questions:

1. Will the material specified and the physical design features adopted lend themselves to processing at minimum cost as well as adequate production speed?
2. Will the most economical production method available maintain, at the desired or necessary output speed, the required dimensional tolerances?

Arrival at the most satisfactory answer to these questions more often than not becomes to a certain extent a matter of compromise. For instance, in a great majority of cases, close tolerances decrease severely the maximum possible production speed—as well as increase the scrap output—and, as a consequence, increase the cost per piece. Each production method, it must be remembered, has a well-established level of precision which can be maintained in continuous mass production without exceeding the normal basic costs. No amount of inspection actually will improve this level, and for practical low-cost production it must be observed. It also must be recognized that each method has a minimum production-quantity level, below which the cost per part would be excessive, although this value may vary widely depending upon specific design characteristics.

Actually, the drawings and speci-

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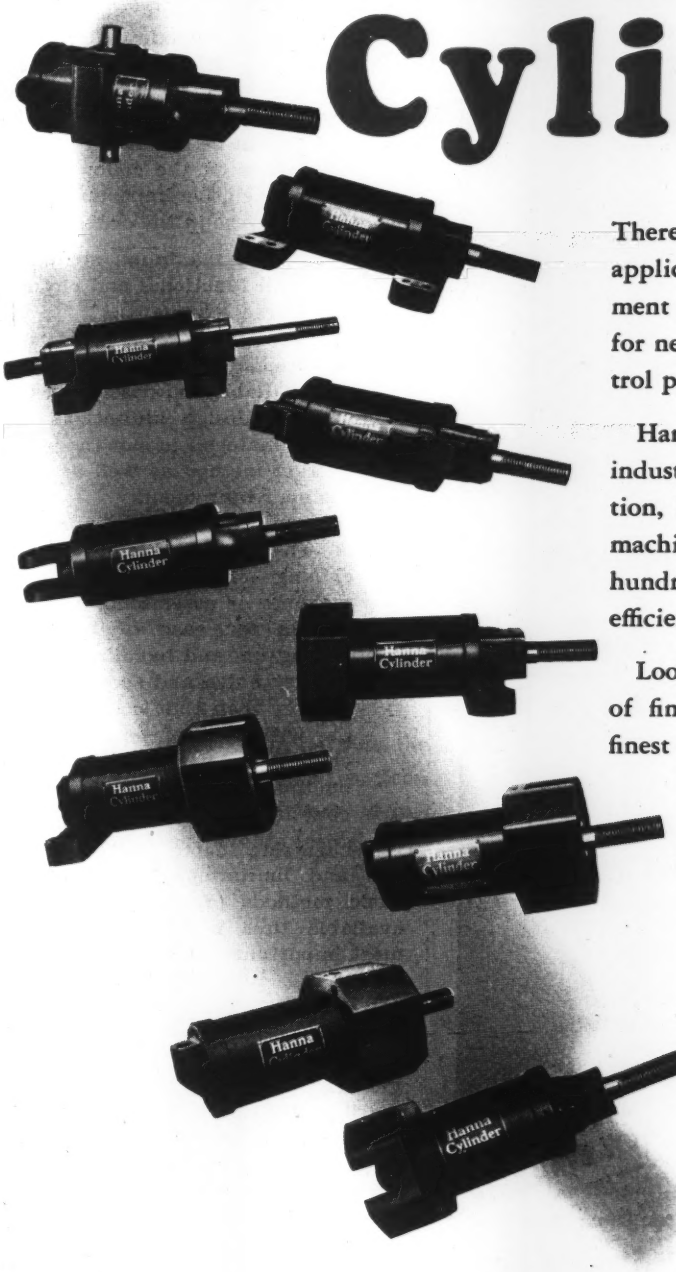

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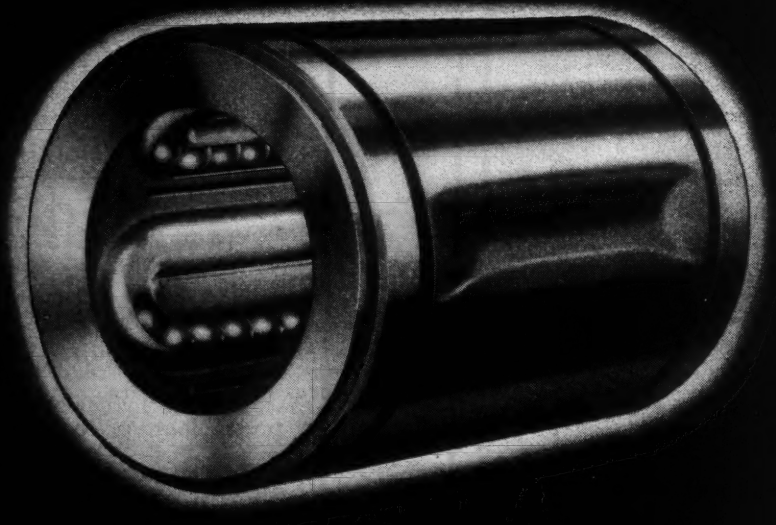

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PROGRESSIVE MANUFACTURERS USE BALL BUSHINGS — A MAJOR IMPROVEMENT AT A MINOR COST

fications of the designer establish minimum manufacturing cost to a far greater degree than is often recognized. Regardless of efficiency, tooling, or purchasing efforts, the designer's influence on manufacturing costs sets the limits beyond which little improvement can be made. Total design effect upon manufacturing costs has been shown to average as much as 35 per cent of the major over-all costs consisting of raw materials, equipment, direct and indirect labor, tooling, and engineering.

Sound design which incorporates the advantages of maximum economy in manufacture therefore necessitates consideration both separately and in combination of a number of basic rules which can be outlined generally along the lines in the following, although their relative importance need not necessarily be in the order shown.

1. Design for maximum simplicity of all functional and physical characteristics
2. Design for the most economical production method or methods available and observe their inherent design limitations
3. Select material to suit the production method as well as the design requirements
4. Design for minimum number of separate operations in machining, finishing, forming, molding, or assembling
5. Design for ease of holding, setting up, and handling parts
6. Specify finish and accuracy no greater than that commensurate with type of part or machine being designed and production method or methods contemplated.

Recognizing the economic possibilities and limitations of the various basic methods of manufacture now available thus becomes one of the most important considerations for the designer. Reduced manufacturing costs, simplified processing, decreased material waste, and design improvement must find their origin in the engineering department, and depend primarily upon the extent to which the parts have been "processed" or "designed for production," so as to lend themselves to manufacture at minimum cost. *From a paper by Roger W. Bolz, associate editor,* MACHINE DESIGN, *presented at the ASME Annual meeting in New York.*

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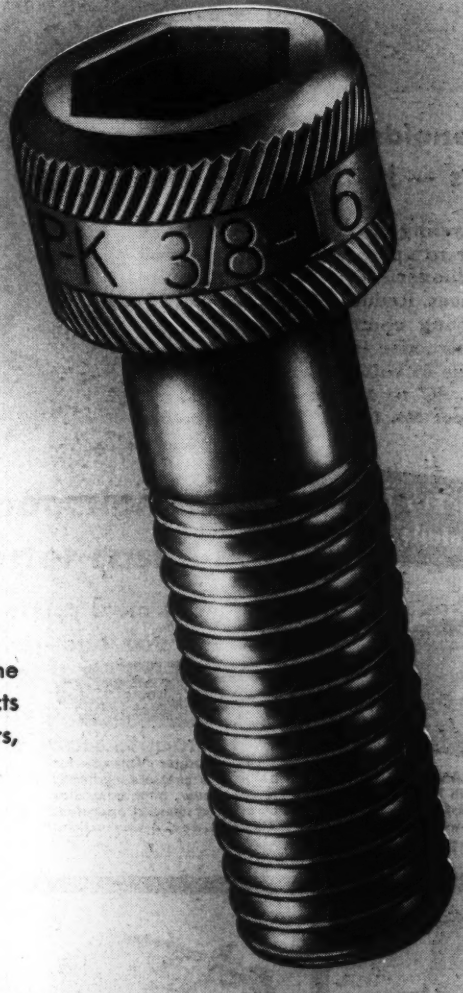

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and that GEAR GRIP† makes 'em slip-proof!

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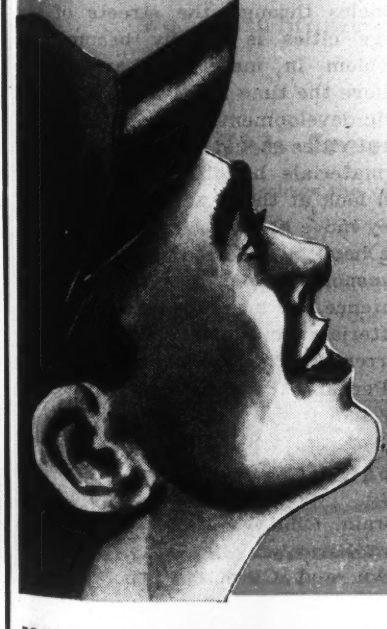

Even when fingers are oily, the GEAR GRIP on P-K* Socket Head Cap Screws prevents slipping. When fingers can fly, the work flies!

Only Parker-Kalon offers the SIZE-MARK and GEAR GRIP. Take advantage of these exclusive features—watch your product's assembly costs go down, its sales appeal go up.

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Quick-As-Wink

type "SA" solenoid pilot operated single plunger control valves

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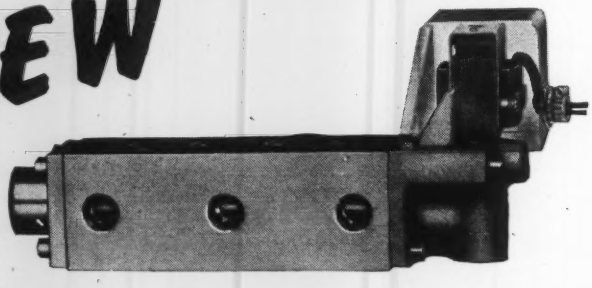


▶smaller, shorter stroke solenoids — lower amperage
▶simpler electrical controls — high air economy...

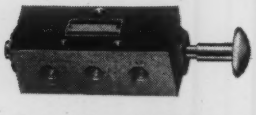
● Small solenoids traveling through only a 1/8" stroke move a small pilot valve plunger to apply air to the operating piston to move the main valve plunger. All operating parts are rugged, yet weigh only a few ounces. Reduced amperage eliminates intermediate relays, simplifying control circuits. Positive high cycle operation, without destructive impact, reduces maintenance and minimizes trouble due to voltage variations. 2-way, 3-way, 4-way and 5-way designs. 3/8" to 1" sizes, with bucking cylinder return. ***Send for Data Sheet No. 1611. It gives full details.***

Individual DATA SHEETS for Each Valve — give complete details. Write today!

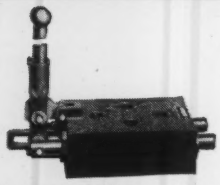
Hand Operated Air Valves—wide variety of uses. 2-way, 3-way, 4-way neutral position and compound exhaust.

Foot Operated Air Valves—workman has both hands free, speeding production. 2-way, 3-way and 4-way actions.

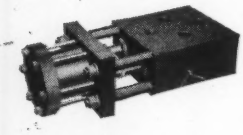
Single Plunger Valves—for air or low pressure hydraulic service. Lever, pilot, cam, diaphragm or solenoid operated. 2-way, 3-way, 4-way actions.



Series "O" and "OE" Valves—for air or hydraulic service up to 125 PSI. Push-pull, cam, pilot, diaphragm and solenoid operated. 1/8" and 1/4" pipe connections. 2-way, 3-way, 4-way and 5-way actions.



Hydraulic Valves—Up to 5000 PSI. Conservatively rated. 1/2", 3/4", 1" and 1 1/2" sizes. 2-way, 3-way, 4-way actions.



Hydraulic Valves—Up to 5000 PSI. Pilot cylinder operated. 1/2", 3/4", 1", 1 1/2" 2", 2 1/2" 3" and 4" sizes. 2-way, 3-way, 4-way actions.

Quick-As-Wink Control Valves

THE HIGHER THE PRESSURE • THE TIGHTER THE SEAL

Manufactured by **C. B. HUNT & SON, Inc.**

1941 East Pershing Street, Salem, Ohio

ride along a moving sidewalk, luggage in front or back of us, free from the discomfort of struggling with baggage?

The day of the widespread use of baggage conveyors is here at hand. At this moment, a major hotel chain is contemplating luggage conveyors running from street curb to hotel lobby.

While on the subject of railroad stations, I would like to point out an excellent example of the need for a conveyor system a few blocks from this hotel. I refer to the subway train that shuttles weary, crowded passengers from Times Square to Grand Central station. I believe that in our lifetime we will see that dirty, uncomfortable shuttle replaced by a moving sidewalk that will carry passengers quickly and safely between the two terminals. Furthermore, there's no reason why a connecting link could not add the Pennsylvania Station to the circuit.

Eliminate Truck Traffic?

Along the same line would be a means to relieve the congestion of city traffic, particularly heavy trucks jamming the streets and turning sidewalks into unloading platforms. One remedy, which its backers claim will rid the streets of 25 per cent of the large trucks, is to build large trucking depots at the edges of the central business district. Goods would still have to move from stores to terminals, however, but why not have them move on a public conveyor system? Suspended overhead or running underground, such a system could operate on a charge per tonnage basis, paid for by the users. With a freight conveyor like this there would be little need for trucks on our streets.

The movement of both people and vehicles through the streets of our large cities is rapidly becoming a problem in materials handling. I believe the time has arrived when the civic development commissions of our great cities should have on their staffs a materials handling engineer, who can look at the handling of people as they move about a city as he looks at the handling of products as they are transported about a plant. His experience in the study of the flow of materials could solve many of our current traffic problems.

Perhaps the greatest challenge to the industry in the immediate future is the projected 130 mile belt conveyor system known as the Riverlake. With terminals planned for Lorain, Ohio, on Lake Erie and the Ohio River, and spur lines to Youngstown and Cleveland, the twin-belt

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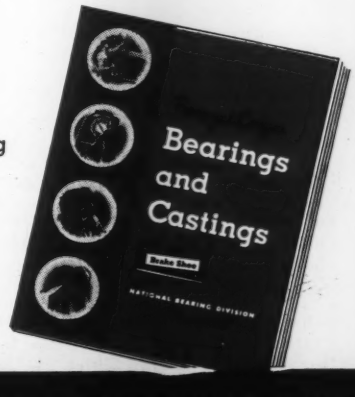

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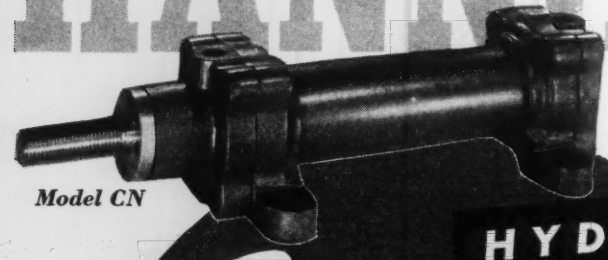

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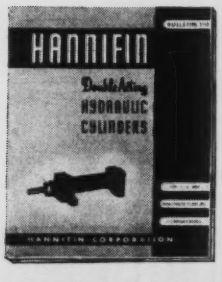

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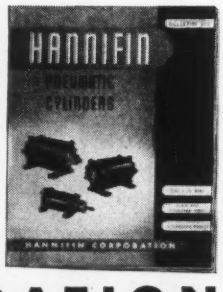
Bulletin 210 **(Right)—"HANNIFIN PNEUMATIC CYLINDERS." 48 page bulletin featuring Hannifin Series "R" and Series "LW" cylinders. Dimensions, tables, engineering data.**



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system could carry 32,000,000 long tons of iron ore a year south from Lake Erie, and 20,000,000 tons of coal north to the lake. Annual savings of 20 to 45 million dollars, depending on tonnages, are anticipated. The conveyor would cut straight across the countryside, paying little respect to hill and dale, and offer a continuous and dependable means of delivering vital raw materials.

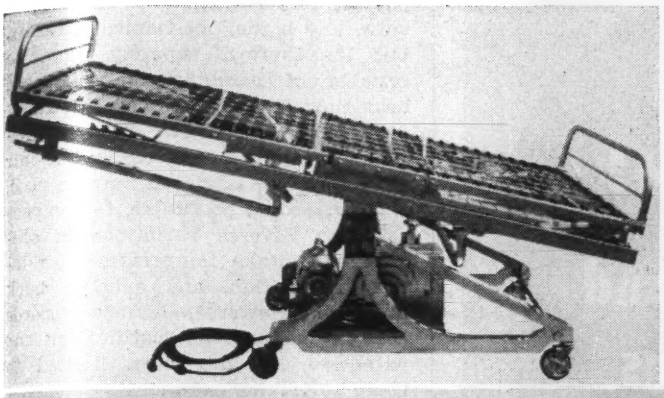
With self-unloader ships, baggage conveyors, and ideas for moving sidewalks, a start has been made. But much more mechanization must take place before our arrival and departure confusion is resolved. Until this problem is solved, we have reached a point of diminishing returns in our transportation system at sea, rail, truck, and air ports. *From a paper by Harold Von Thaden, vice president Hewitt-Robins Inc., presented at the Annual Meeting of the ASME in New York.*

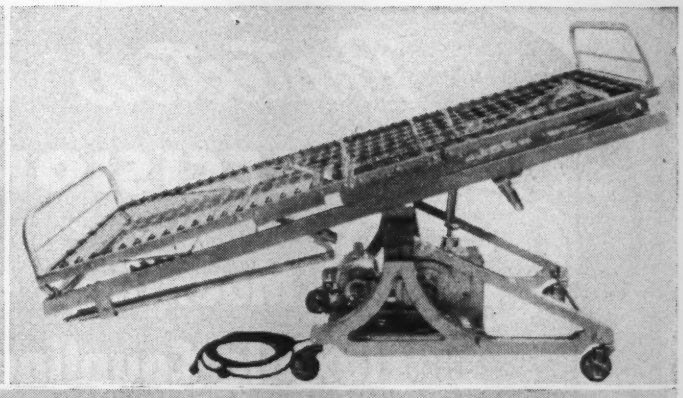
Why Supercharge?

IN THE early development of the automotive diesel engine, two of the principal problems confronting manufacturers were designing and developing a commercial engine, and overcoming the inhibitions and skepticisms of the prospective owners and operators. The popularity and competitive position of the diesel engine of today, is testimony to the success which has been achieved in overcoming these criticisms.

Since the very beginning, the trend has been toward greater power-to-weight ratio in trucks, and as yet, there are no signs of leveling off. Therefore, in the present era, one of the foremost considerations in research work is for more horsepower output from a given size engine, with improved performance, efficiency, and durability; the objective being less weight and space requirement for a better power plant.

To increase the horsepower output of an engine, there are four logical steps: (1) Improve combustion cycle, (2) improve mechanical efficiency, (3) increase speed, and (4) supercharge. The mechanical efficiency and combustion process have been refined and improved to the extent that any further gain will not be of the spectacular type. The cream has been "skimmed off" and future improvement will come gradually from refinement of many small details, and at the expense of long and tedious research. Increasing the engine rpm entails many problems of inertia loads, wear, durability, and functioning, which are likely to involve every auxiliary and component part of the





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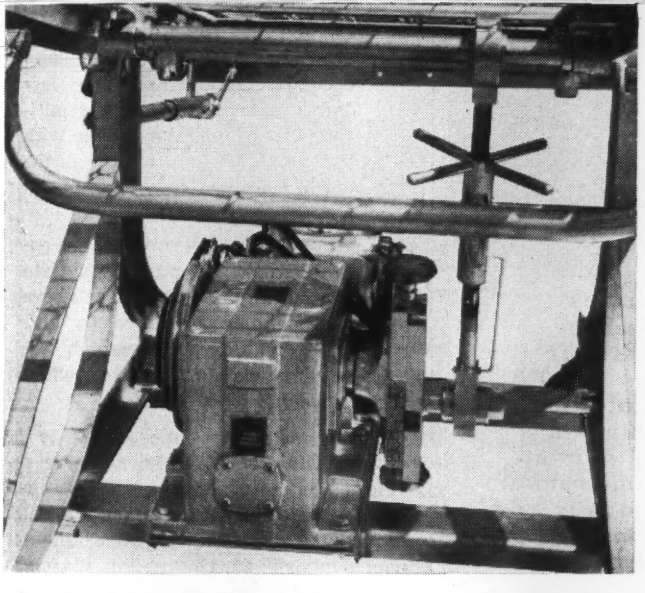
SETS THE PRESCRIBED SPEED FOR THE FAMOUS

ROCKING RESPIRATORY



The VASOSCILLATOR BED, pictured above is an accepted treatment for Buerger's Disease (hardening of the arteries). Tested for the treatment of polio and other vasculatory ailments, it is winning wide popularity among government institutions, hospitals and medical men all over the country. Its gentle, rocking motion provides patient comfort and aids materially in the treatment of respiratory diseases.

Obviously, the chief operating requirements are smoothness, quietness and thorough dependability. And the manufacturers found exactly these characteristics in a Stock D4 Ohio Gear Speed Reducer.

Further, in utilizing a stock unit they avoided the extra cost and time-consuming delays usually encountered when special units are specified.

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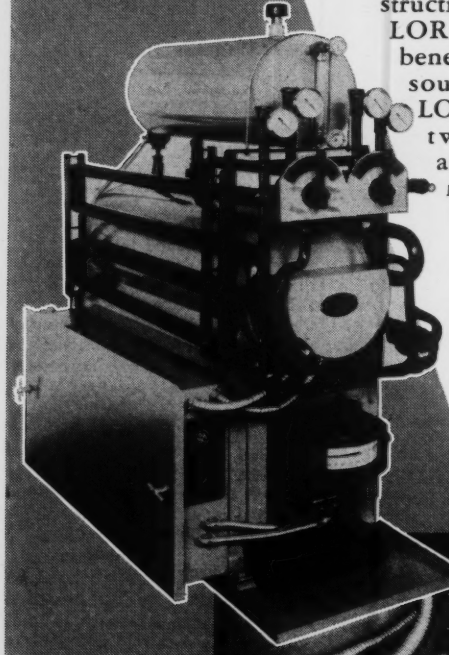
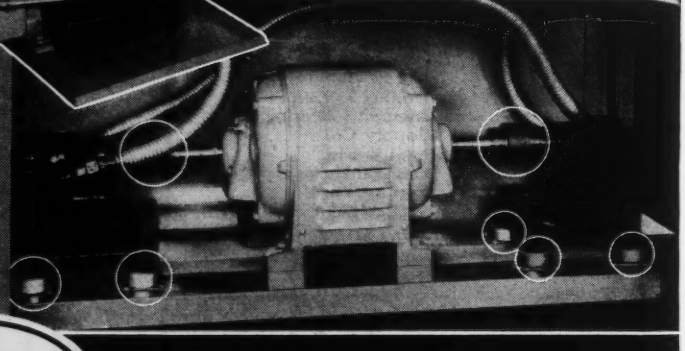
Precision of temperature control is the basis for uniform quality in many products. Typical of the equipment which automatically maintains process temperatures within close limits under varying load conditions is the Royle Temperature Control Unit shown here!

It is also typical of modern equipment design that LORD products are used to protect sensitive controls against destructive vibration. Note that LORD Flexible Mountings beneath each pump isolate the source of disturbance; and LORD Flexible Couplings between motor and pumps accommodate shaft misalignment and dampen shaft vibration.

In addition to protecting accuracy, LORD Mountings and Couplings add sales appeal by making mechanical products smoother and quieter. Learn how LORD Vibration Control can improve your product. Submit details for analysis and recommendation; or request that the LORD representative call.





LORD BONDED RUBBER Vibration Control

LORD MANUFACTURING COMPANY · ERIE, PA.

Canadian Representative: Railway & Power Engineering Corp. Ltd.

engine. Supercharging need not involve any higher mechanical stresses, but the thermal capacity must be capable of handling the increased heat flow from the higher output.

Since supercharging is an artificial means of increasing the air capacity of an engine it may be used, if justified and profitable, to compensate for adverse variations in altitude, air intake temperature, air intake restriction, and exhaust back pressure. However, history records that in the past its justification and extensive use has been limited to three particular cases:

1. To help engines that were inherently bad breathers, that is, engines that had an air induction system which was not conducive to good air flow in pounds per minute, particularly, at the higher engine speeds
2. To compensate for the loss in density of air at increased altitudes. In this case, the supercharger is geared to pump enough volume of the less dense air at the higher altitudes to supply the engine with the same pounds of air as the engine consumes with natural aspiration at sea level
3. To actually supercharge the engine, that is, pump air into the cylinder at pressures above atmospheric pressure to give extra pounds of air which will burn more fuel, and produce more horsepower.

It is possible to supercharge to the extent that all the horsepower developed by the engine is consumed in driving the supercharger, which leaves no horsepower available for useful work at the drive shaft. To keep the horsepower lost in driving the supercharger to a minimum, it is obvious that supercharger and engine should be carefully tailored to suit the actual air requirements.

The claims of 85 to 90 per cent efficiency for the axial flow supercharger make it appear attractive and worthy of consideration, particularly if a design can be made to perform satisfactorily and efficiently throughout the engine speed range. Metallurgical developments permitting the use of the exhaust turboblower at exhaust temperatures above 1100 F open the way for that possibility, which is attractive also. Particularly because it is driven by the energy of the exhaust gas which is normally a complete loss to the engine. *From a paper by Neville M. Reiners, research laboratory, manager, Cummins Engine Co. Inc., presented at the SAE National West Coast Meeting at Portland, Oregon.*

NATIONAL OIL SEAL LOGBOOK

USE OF NEW UNITARY OIL SEALS INSTEAD OF EXPENSIVE FACE TYPES

Many tough applications where face type seals have been thought necessary are now utilizing unitary oil seals at substantial savings in cost. Farm implements, tractors, track tread units and other machinery which operate in heavy dirt under adverse conditions are typical of these applications.

Figure 1—Face type oil seal.

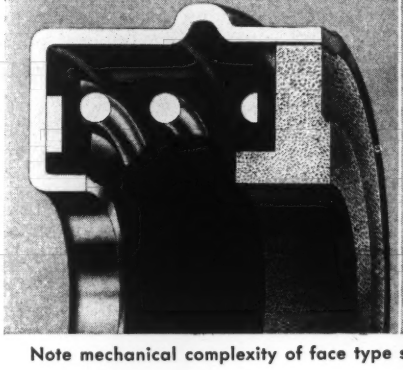
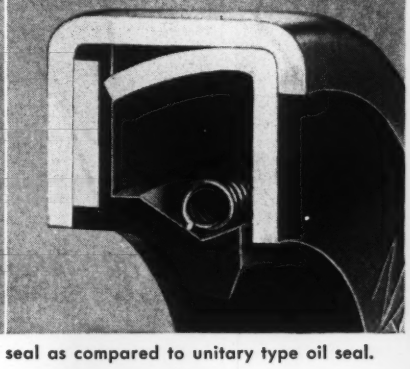


Figure 2—Unitary type oil seal.



Note mechanical complexity of face type seal as compared to unitary type oil seal.

The advent of new sealing member of synthetic compounds and development of new treatments for leather, coupled with a considerable advance in mechanical design of the oil seal itself, have made practical their use in some of the most rugged and exacting applications. Savings are effected in the cost of the sealing unit and in the cost of manufacturing of the equipment itself. In addition, servicing of the equipment is greatly simplified.

The sectional drawings (Figs. 1 & 2) show the complexity of the face type seal as compared to the unitary type, which accounts for the low cost of the one versus the other. It is apparent that a unitary type seal can be more easily incorporated mechanically with resultant savings in the manufacture of the equipment.

Many new unitary oil seal designs have been developed which solve difficult problems. A few of these are shown (Figs. 3, 4 & 5). The dual wipe seal shown (Fig. 3), having Syntech* sealing members, was designed for a farm implement application which formerly utilized an expensive face type seal. This particular seal provides vastly improved performance in this type of equipment.

National Oil Seal engineers recommend face type oil seals only when thorough research proves them absolutely necessary and practical.

No matter what your problems—whether requiring face types, special sealing member compounds or adaptations of stock designs—National Oil Seal engineers will gladly help you. A quarter century of experience is your assurance of dependable assistance.

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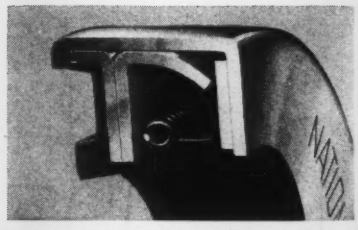

Figure 3—National Series 330,000 Syntech* dual wipe oil seal.

Figure 4—National convoluted flex type oil seal permits extreme shaft misalignment.

Figure 5—National Series 350,000 rubber-covered oil seal requires less critical bore.

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Business Machines

DUPLICATOR. New Ditto Model D-45 for heavy-duty office work. Reproduces 4 colors at once, 100 copies per minute, 300 to 500 copies per master. Magnetic clutch contributes to silent operation. Dial-controlled margin adjustment provides accurate register when master does not register with copy sheets. Foot-pedal operated clamp on drum frees operator's hands. Optional line printing tray automatically adjusts for copying each line on a master. Handles material to 14 by 15½ in. Ditto Inc., Chicago, Ill.

CREDIT BALANCE ADDING MACHINE. Visually indicates a credit balance by flashing a red light above keyboard. All subcredits and totals printed on tape in red ink. All totals, debit or credit, spaced apart from entries to distinguish from column figures. Machine operates automatically, employing rotary action principle to operate at 188 cycles per minute. Clary Multiplier Corp., San Gabriel, Calif.

ADDRESSER. Hand-operated model for moderate-size mailing lists. Prints from paper tape using colorless fluid. Tape good for 100 printings. Variable margin guide positions address from ⅜ to 4½ in. from top or bottom of mailing piece. Tape automatically moves to next position after each impression. Spool crank provided for rewinding tape. Machine handles about 1000 pieces per hour. Empire Specialties Service, Long Island City, N. Y.

Commercial

FROZEN JUICE CABINETS. Self-service, open type units with 5.3 or 8.2 cu ft capacity. Constructed of steel coated with enamel, with zinc-coated walls and bottom and stainless steel top. Condenser located under cabinet with compressor and controls in compartment at one end. Large model holds 775 six-oz cans, has dimensions 54¾ by 32¾ by 30½ in.; other model holds 457 six-oz cans, has dimensions 42¼ by 32¾ by 30½ in. Frigidaire Division, GMC, Dayton, O.

COOKING RANGES. All-purpose gas models with 2, 3 or 4 burners. For utility cooking in restaurants, fountains, camps, etc. Made of heavy-duty chrome with black plas-

yes... an oil seal that's tailor-made to *resist* corrosion

● If corrosive conditions are shortening the life of your oil seals, the Johns-Manville Clipper Seal should provide a practical solution to your problem.

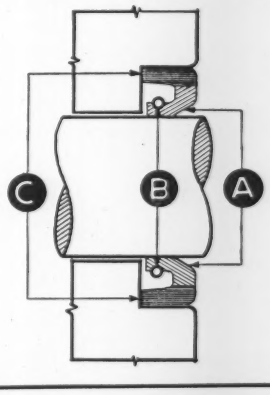
Here's why: The Clipper Seal's molded body is entirely non-metallic and is, therefore, unaffected by most forms of corrosion. To meet special conditions, the garter spring which holds the lip in contact with the shaft can be furnished in various corrosion-resistant metals . . . *or Clipper Seals of special design that do not require garter springs may be used.*

The one-piece, concentric molded design of Clipper Seals also assures a number of other advantages. The hard, tough outer heel of the Clipper Seal is resilient enough to conform even to a slightly out-of-round cavity. And the soft, pliable inner lip always maintains a light, but positive sealing pressure on the shaft, with minimum wear on the seal.

Clipper Seals are quick and easy to install, may be had in split or endless types, are available in sizes from ¼" I.D. up to 66" O.D. If you have a special sealing requirement, or wish to consult about a special design problem, write Johns-Manville, Box 290, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

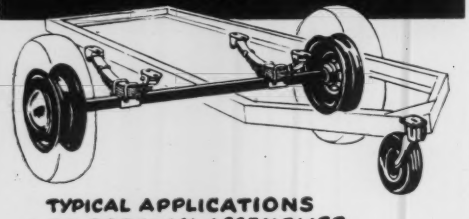
Here's how *Clipper Seal* works:



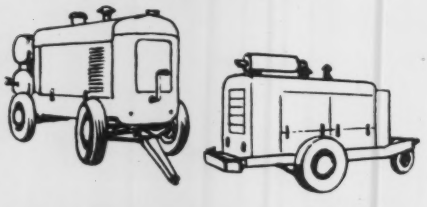
The flexible lip (A) is held in light but firm contact with the shaft by means of the garter spring (B). Pressure on shaft is carefully pre-determined to minimize wear, yet effectively seal against leakage. The rigid heel (C) provides a press fit in the cavity, assuring a tight lubricant-retaining seal at this point also.

Johns-Manville **PACKINGS & GASKETS**

UNITED
Caravan
AXLES
COMPLETE
PACKAGED
ASSEMBLIES



TYPICAL APPLICATIONS
OF CARAVAN ASSEMBLIES



CARAVAN AXLES SOLVE PORTABILITY PROBLEMS

NOW . . . UNITED offers you 2-wheel (single axle) or 4-wheel (front and rear axle) assemblies in complete kits to provide full spring mounted portability for a wide variety of industrial equipment.

CAPACITIES range from 1000 to more than 12,000 pounds. Brakes and Titanic automatic brake control optional. Retractable swivel caster wheel assembly is available for two-wheel units. Mounting brackets will be furnished for under or side-frame attachment.

UNITED has a complete line of equipment including SPECIAL AXLES (straight or drop) and stub spindles.

Let UNITED'S engineers solve your portable equipment problems. Write today for the new "CARAVAN AXLES" catalog or call Bedford 1323 for immediate service.

WRITE FOR CATALOG

THE UNITED MFG. COMPANY

214 Interstate Street, Bedford, Ohio

tic feet and burner handle controls. Each burner has high and low heat with separate flash type pilot light. Units available for natural or manufactured gas or liquefied petroleum. Cory Corp., Chicago, Ill.

Domestic

AUTOMATIC DISHWASHER. Front-opening, top-loading model slides out like a drawer, retains convenience of unbroken counter work surface. Washing, rinsing and drying cycles controlled by impulse type timer which activates 2 solenoids. One operates water inlet valve, other starts and stops drain pump. Total cycle time, 37 minutes. Racks hold equivalent of dinner service for 8. Aluminum impeller blade creates washing and rinsing action. Diverter directs water evenly to all parts of washer. Heating element speeds drying cycle. Available in 48-in. electric sink, 24-in. free standing and undercounter models. Westinghouse Electric Corp., Pittsburgh, Pa.

Heating and Ventilating

AIR CONDITIONER. Acts as room deodorizer and humidifier. Draws air through water spray to remove odors, smoke, dirt and dust, etc. Air then recirculated into room by fan. Unit washes 13,000 cu ft air per hour. Fresh'nd-Aire Co., Chicago, Ill.

HEATER-FAN. Combines portable electric heater and fan. Table size unit stands 11⅝ in. high, can be mounted in any position. Heater unit has 1320-watt capacity. Heating coils can be turned off independently of fan to permit use for cooling. Fresh'nd Aire Co., Chicago, Ill.

Maintenance

PAINT HEATER. Circulating type paint heater sprays directly from paint container without use of pressure tanks. Paint pumped through heater to spray gun at any desired temperature. Paint pressure and temperature shown on gages; fluid pressure set by regulating valve. Explosion-proof heater uses two 1000-watt, cartridge type heaters adjustable to ½-degree. Unit powered by ½-hp, explosion-proof motor from 110 or 220-volt a-c line. Air motor uses 2 to 5 cfm air at 40 psi. Bede Products Inc., Cleveland, O.

Manufacturing

PRESS. Redesigned model of 1 ton plus Midget press. New motor mount with belt tension stop increases belt and motor life. Relocated motor mount assembly lowers center of gravity of unit. Frame

It's the Hi-Density Lead that makes

MICROTOMIC
"VAN DYKE"

your one best bet for tracings that "Come Clean" in reproduction!

Top that off with true UNIFORMITY OF GRADING and you have every reason for preferring MICROTOMICS. 18 degrees, from 9H to 7B.

TRADE MARKS REG. U. S. PAT. OFF.

The EBERHARD FABER Drawing Pencil

AT BLUEPRINT & ENGINEERING SUPPLY HOUSES

As the white outline indicates, a standard unit of much greater frame size would be required to do the work of Speedaire.

Speedaire-equipped agitator built by Buflovak Equipment Division, Blaw-Knox Company.

SPEEDAIRE agitator drive saves $267

HERE'S another equipment builder who uses Speedaire because it is compactly designed, lighter in weight and lower in cost. Compared to the conventional worm gear drive required to operate this steam jacketed vertical agitator, Speedaire offers these advantages:

1. It occupies only one-third the space,
2. It weighs less than half as much,
3. It saves $267 per unit in cost.

Speedaire is Cleveland's fan-cooled worm-gear speed reducer. Because it is fan-cooled, Speedaire will do more work —will deliver up to *double the horsepower* of standard worm units of equal frame size, at usual motor speeds. It can be installed economically on many applications where other types have been used heretofore—giving you the advantage of a compact right-angle drive. Speedaire gives the same long, trouble-free service characteristic of all Clevelands.

For full description, send for Catalog 300. The Cleveland Worm & Gear Co., 3265 E. 80th St., Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND Worm Gear Speed Reducers

EAGLE TIMERS

FOR CONTROLLING INDUSTRIAL PROCESSES

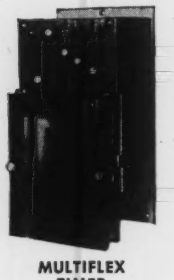
MICROFLEX TIMER

MICROMETER DIAL

Provides exceptional timing accuracy where a circuit is to close or open with a time delay. Timing adjustable over wide range.

MULTIPLE CIRCUIT —ADJUSTABLE

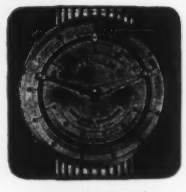
Use where several circuits are to close in a predetermined sequence. Time of closing and opening each circuit is adjustable.



MULTIFLEX TIMER

REPEAT CYCLE

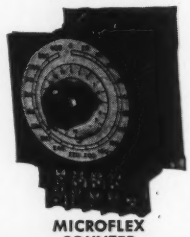
Use where ON-OFF operation is continuously repeated. The ON time and OFF time are each adjustable on the dial.



FLEXOPULSE

COUNTER

Use for limiting a process to an exact number of operations. The counter contact opens after 1 to 400 electrical impulses as selected on dial. Automatic spring reset.



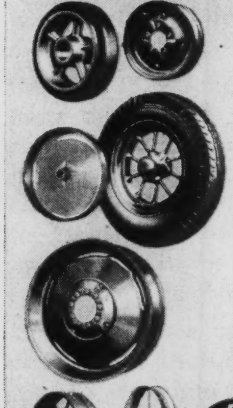
MICROFLEX COUNTER

Write for catalog Bulletin 291 or send details of your control problems to Eagle for recommendations. Consult Eagle representatives located in the principal cities.

EAGLE Signal Corporation
MOLINE ILLINOIS

ELECTRIC WHEELS

Designed to do the Job

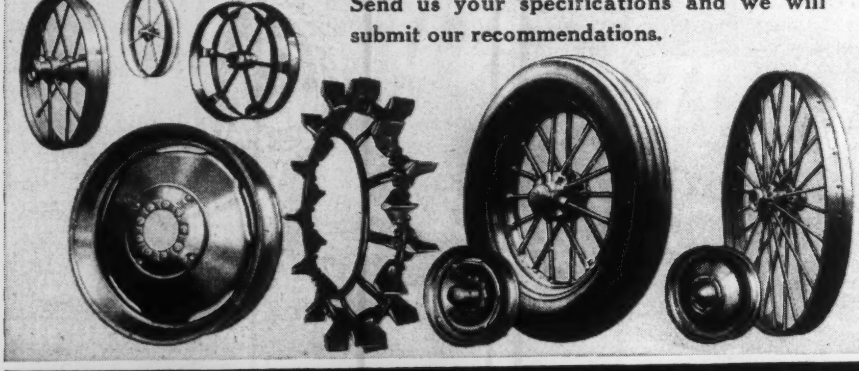


Wheels and Axles are our business, and our engineers are well qualified to recommend the most efficient assembly for your product.

Our factory is modern and tooled for low cost production. We have supplied manufacturers in many different industries for more than 50 years.

Standard or Special, ELECTRIC Spoke-type or Disc Wheels are built for most types of portable equipment.

Send us your specifications and we will submit our recommendations.



ELECTRIC WHEEL CO., 2915 Pine, Quincy, Ill.

has been strengthened and lubrication improved. Benchmaster Mfg. Co., Los Angeles, Calif.

PORTABLE DRILL PRESS. For use with any ⅜ to ½-in. electric drill. Weight, 26 lb. Can be used as shop tool, at workbench or in hard-to-reach places. Electric drill held by special clamp, leverage provided by anchoring steel chain and applying pressure on lever arm. Sudenga Iron Works, George, Iowa.

BELT GRINDER. For deburring, removing cutter marks, breaking corners, or production grinding of small parts. Belt track mounted on axis centered at motor shaft; abrasive belt can be set at any angle. Belts available for rough, semifinish and finish grinding. H. L. Ramsay & Co., La Grange, Ill.

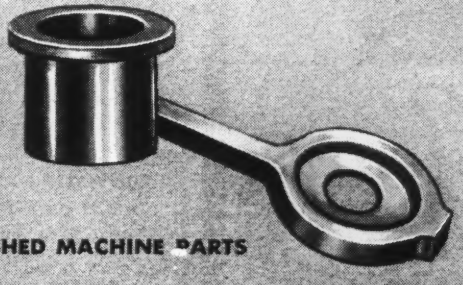
HORIZONTAL DRILLING AND TAPPING MACHINE. For heavy duty boring, drilling, tapping, reaming and spotfacing. Head swivels 45 degrees up and down from horizontal, column swivels 360 degrees. Equipped with 4-in. diameter spindle having 36-in. manual and power feed, 3 spindle-speed ranges from 25 to 300 rpm, and 4 feed ranges from 0.0035 to 0.125-in. per revolution. Thread leads provided for accurate tapping. Rail and head assembly has 48-in. vertical power traverse on 22-in. diameter column. Column and head unit mounted on runway, have 48-in. horizontal travel. Kaukauna Machine Corp., Kaukauna, Wis.

ENGRAVING MACHINE. Pantograph type model for 2-dimensional engraving and profiling in steel dies and molds. Machine has 15-in. throat, handles work to 6 in. high, and uses work table 6 by 12 in. with 3 tee slots. Pantograph ratios range from 1:1 down to infinity. Cutter spindle has 6 speeds ranging from 5000 to 14,000 rpm, powered by ¼-hp motor. Bench or floor models both have 6-in. cross feed and 6½-in. longitudinal feed. H. P. Preis Engraving Machine Co., Hillside, N. J.

SHEET CUTTER. For straight, circular and irregular cutting and for folding, beading and slotting of sheet steel and plate. Capacity: 7/32-in. mild steel; cuts circles from 3 5/32 to 40-in. diameter; has throat depth of 42 in. Mechanism enclosed and operates in oil bath. The American Pullmax Co. Inc., Chicago, Ill.

ARC WELDER. Generator powered by 4-cylinder, 31-hp, air-cooled Wisconsin engine. Double shields keep both generator bearings dirt-free and retain grease. Control wheel has 5 positions, with ample overlap to insure fine current settings. Generator is self-excited with excitation of main field supplied by

QUALITY



OIL-CUSHIONED BEARINGS

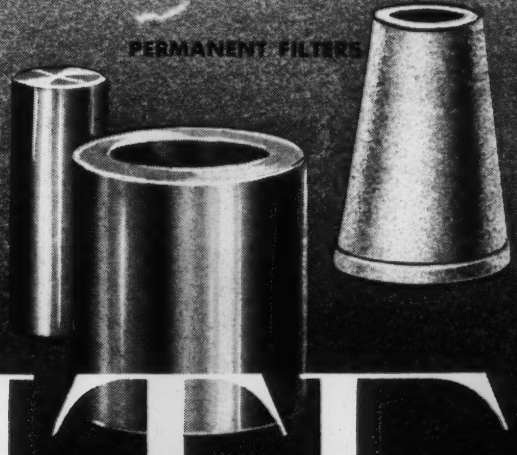
FINISHED MACHINE PARTS

★ 20 years of production experience.
★ New plant and equipment.
★ Virgin materials of highest purity.
★ Recognized management and technical personnel.
★ Electronic inspection devices and quality control.

SERVICE

★ Extensive staff of home office and field engineers.
★ Batteries of presses and other equipment for quick service.
★ Production tools for more than 25,000 different finished products.
★ 3000 additional engineers for consultation on technical problems.
★ Depots in every state and throughout Canada for on the spot service.

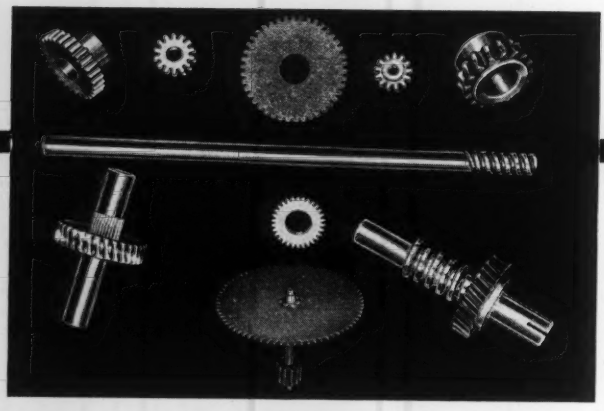
PERMANENT FILTERS



CORED AND BAR STOCK

OILITE

AMPLEX MANUFACTURING COMPANY
SUBSIDIARY OF CHRYSLER CORPORATION
DETROIT 31, MICHIGAN



Rynel CERTIFIED Gears

FOR ALL FRACTIONAL HORSE POWER PURPOSES

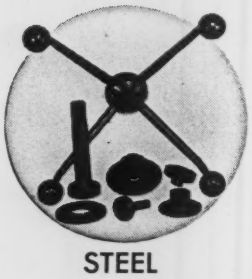
OUR SPECIAL EQUIPMENT MAKES PRECISION PRODUCTION IN VOLUME A REAL ECONOMY. CONSULT OUR GEAR EXPERTS ON YOUR NEXT PROBLEM.

Rynel Corporation
STERLING, ILLINOIS

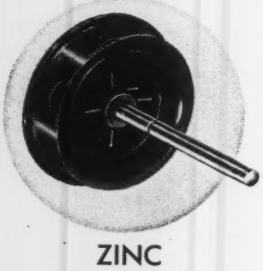
BLACK MAGIC

ECONOMICAL-ATTRACTIVE-PROTECTIVE CHEMICAL FINISHES

FOR FERROUS AND NON FERROUS METALS



STEEL



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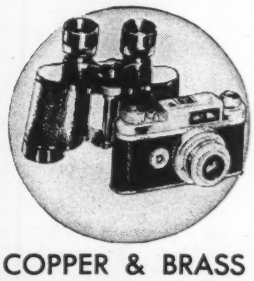
CADMIUM

One Bath Processes

Simple to operate—economical to use!

1. BLACK MAGIC Processes afford a rich, permanent black finish integral with the metal surface; will not chip, flake or peel.
2. Resistant to heat and thermal shock.
3. No dimensional change.
4. Sales appeal and service life.
5. Optical black finish.

WRITE for "Black Book" of details on BLACK MAGIC. See the finish on your parts. Send samples for processing.



COPPER & BRASS

MITCHELL-BRADFORD CHEMICAL COMPANY
MODERN METAL FINISHES
• 2446M MAIN ST., STRATFORD, CONN. •

BLACK-MAGIC OXIDE BLACKING SALTS
WITCH-DIP & WITCH-OIL FINAL FINISHES

SILCO Glass-Base PROTECTIVE COATING
HEAT TREATING SALTS. CLEANERS. ETC.

auxiliary brush. Engine uses magneto ignition and hand cranking to eliminate battery maintenance. Overall dimensions: length, 58½ in.; width, 25⅝ in.; height, 47 in. Weight, 825 lb. Trailer mounting available as optional equipment. Air Reduction Sales Co., New York, N. Y.

PNEUMATIC RIVETERS. Special multiple-head models made to suit each job. Utilize standard heads which can be set as close as 2¾-in. centers. Air supplied through single solenoid-operated air valve controlled by foot switch in conjunction with adjustable timer which limits riveting cycle time. Hill Machinery Co., Rockford, Ill.

DIECASTING MACHINE. For zinc. Pressure on 8-lb zinc casting, 1300 psi; pressure on 4-lb zinc casting, 2450 psi. Gooseneck located by 2 machined slots in yoke, eliminating misalignment. Bronze bushing on gooseneck guides plunger stem. Head of plunger held by T-slot coupling attached to plunger cylinder. Pot can be made any size desired. Lester-Phoenix Inc., Cleveland, O.

POLISHING MACHINE. Buffing and polishing machine in 1 or 2-spindle models. Powered by motors of from 1 to 30 hp. Underslung spindle construction provides maximum rigidity to thin spindles. Bearing support arm can be varied to accommodate various size spindles. The Vonnegut Moulder Corp., Indianapolis, Ind.

HYDRAULIC PRESS. For die spotting and tryout, blank development, straightening, molding, stamping, etc. Finger-tip control for regulating pressure. Fast approach and slow movement of ram for last part of stroke provide better control and decrease die breakage. Pressure can be applied in either direction of ram movement. Bunell Machine and Tool Co., Cleveland, O.

PORTABLE ELECTRIC DRILL. Capacity; ¼-in. in steel, ½-in. in wood: size; 7¾ in. long including Jacobs chuck, 2¾ in diameter: weight; 3½ lb. Includes pistol-grip handle, thrust plate on spindle, dynamically-balanced armature. No-load idle speed, 1600 rpm. Distance from center of chuck spindle to top of diecast aluminum housing, ⅝-in. Fasco Industries Inc., Rochester, N. Y.

PORTABLE ELECTRIC SANDER. For intermittent sanding, metal finishing, touch-up body work, rust removal, wood surfacing, etc. Has adjustable side handle; weighs 8 lb. Housings are cast aluminum with heat treated gears and grease-sealed bearings. No-load speed, 3500 rpm. Operates on 115 or 220-volt a-c or d-c. Black

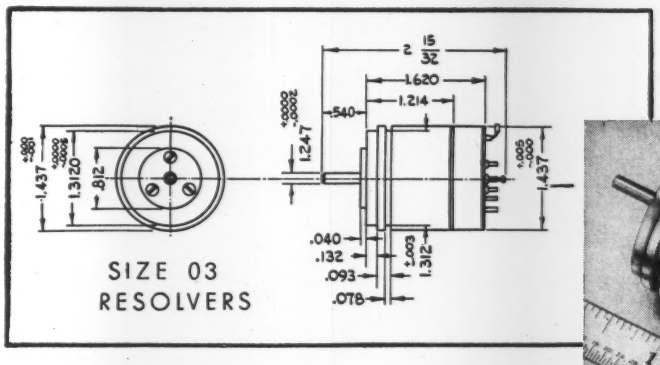
Announcing

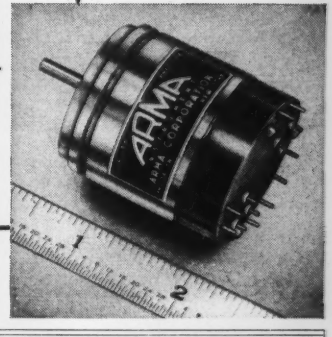
NEW MINIATURE ELECTRICAL RESOLVERS
FOR COMPUTER PROBLEMS OF INDUSTRY

ARMA SIZE 03 (8 types)

KEY COMPONENTS IN ARMA'S POST-WAR TECHNIQUE OF ELECTRICAL "BRAIN BLOCK" INSTRUMENTATION

"Brain Block" instrumentation quickly describes any custom arrangement of light, small, accurate standard Arma components to make precision instruments and controls.





TYPICAL SPECIFICATIONS

SIZE	TYPE	DRAWING NUMBER	FREQ.	INPUTS	OUTPUTS	TRANSFORMATION RATIO (S/P)	PHASE SHIFT	INERTIA (oz. in.)	MAX. STATIC TORQUE (oz. in.)	WEIGHT (lbs.)	MAX. ANGULAR ERROR	MAX. AXIS MISALIGNMENT	REQUIRED TO ATTAIN TABULATED ACCURACIES			
													INPUT VOLTAGE	TEMPERATURE	AMPLIFIER DWG. NO.	AMPLIFIER WEIGHT (lbs.)
03	03JJ400	786832	400 ± 0.5	2	2	1.000 ± .0025	0° 0' ± 3.5'	0.05	0.5	.35	0.12% E_s†	± 7.0'	0.5 to 16.0	15° to 70° C	789640	1.2
03	03KK400	786833	400 ± 0.5	2	1	1.000 ± .0025	0° 0' ± 3.5'	0.05	0.5	.35	0.12% E_s†	± 7.0'	0.5 to 16.0	15° to 70° C	789640	1.2
03	03LL400	786834	400 ± 0.5	1	2	1.000 ± .0025	0° 0' ± 3.5'	0.05	0.5	.35	0.12% E*	± 7.0'	0.5 to 16.0	15° to 70° C	789640	1.2 Note #1
03	03MM400	786835	400 ± 0.5	1	1	1.000 ± .0025	0° 0' ± 3.5'	0.05	0.5	.35	0.12% E*	± 7.0'	0.5 to 16.0	15° to 70° C	789640	1.2 Note #1
03	03NN400	786836	400 ± 0.5	2	2	.955 ± .015	4° 30' ± 30'	0.05	0.5	.35	0.12% E_s†	± 7.0'	0.5 to 16.0	25° C	Not Required	
03	02PP400	786837	400 ± 0.5	2	1	.955 ± .015	4° 30' ± 30'	0.05	0.5	.35	0.12% E_s†	± 7.0'	0.5 to 16.0	25° C	Not Required	
03	03QQ400	786838	400 ± 0.5	1	2	.955 ± .015	4° 30' ± 30'	0.05	0.5	.35	0.12% E*	± 7.0'	0.5 to 16.0	25° C	Not Required	
03	03RR400	786839	400 ± 0.5	1	1	.955 ± .015	4° 30' ± 30'	0.05	0.5	.35	0.12% E*	± 7.0'	0.5 to 16.0	25° C	Not Required	

Deviations shown are maximum — Average deviation is much less. Quadratures and harmonics each never exceed 0.1% of the sum of the input voltages. Characteristics shown are attainable with indicated required auxiliary equipment and good engineering practices for precision circuits. Note #1. One amplifier may be used with two resolvers of this type.

*E = Input
†E_s = Sum of Inputs

These are the resolvers about which management men have been reading: "One of the means by which the many fast changing variables of industry can be coordinated and electrically translated is Arma's electrical resolver . . . the "brain block" that replaced a formidable aggregation of gears and slides previously used to solve the trigonometric functions. It is used in instrumentation involving computers and action-triggering circuits. And, resolvers come off Arma production lines accurate to a degree seldom equalled outside the precision model shop. They fit interchangeably into instrument assemblies."

RESOLVER CATALOG JUST PRINTED GIVES COMPLETE DETAILS ASK FOR A COPY

ARMA CORPORATION

254 36th STREET, BROOKLYN 32, N. Y.

SUBSIDIARY OF AMERICAN BOSCH CORPORATION

ARMA PRODUCTS RELEASED FOR PRIVATE INDUSTRY

ARMA ELECTRICAL RESOLVERS* • ARMA SYNCHROS • ARMA INDUCTION MOTORS • ARMA INDUCTION GENERATORS • ARMA MECHANICAL DIFFERENTIALS • ARMA ALTERNATING VOLTAGE COMPARATOR • COMPUTING MECHANISMS • INDUSTRIAL CONTROLS • STABILIZATION DEVICES • NAVIGATIONAL EQUIPMENT • LIMITRON AUTOMATIC INSPECTION SYSTEM

* Licensed for use under Arma patents Nos. 2,465,624 and 2,467,646. License information available.

QUALITY ARMA INSTRUMENT PRECISION

WITHSTAND EXTREME TEMPERATURES RANGING FROM −160° to +500° F.

SILICONE RUBBER PARTS play important roles in automotive, aviation, electrical, refrigeration, and original equipment manufacturing industries because they retain desirable rubber-like properties at temperatures from −160° to +500°.

SILICONE RUBBER PARTS resist permanent compression, have excellent dielectric properties, and withstand hot lubricating oils, Freon, liquid ammonia, sulphur dioxide, ozone, tricresyl phosphate, and chlorinated hydrocarbons.

SILICONE RUBBER PARTS can replace metal constructions forced upon design engineers by limited thermal stability of organic rubbers. Gaskets, diaphragms, grommets, washers, sleeves, channel, packing, tubing, and numerous other molded, extruded, punched, and lathe-cut products can be fabricated from Silicone stocks.

Write today for complete information or quotations.

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RUBBER COMPANY
Specify Stalwart for Quality Custom Rubber Products
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BEDFORD, OHIO

& Decker Mfg. Co., Towson, Md.

BAND SAW. Spiral blade presents 360 degree cutting edge which cuts in any direction, permitting operator to cut and back out of work in shortest direction. Cuts most materials, including steel, foam rubber, etc. without chipping or tearing. Model 100A has 12-in. throat, 8½-in. clearance under guide bar, 4-in blade tension adjustment, and table tilt of 45 degrees right and 5 degrees left. Powered by ⅓-hp, 110-volt motor. Model 500A has same dimensions except powered by ½-hp motor, has variable speed drive and planetary transmission providing speed range of 70 to 5000 fpm. Tyler Manufacturing Co., New York, N. Y.

Materials Handling

BULLDOZER BLADE. Attaches to Model D Roadster Tournapull. Blade suspended in front of unit, is cable-actuated and electrically controlled by switch on dash control panel. Blade has bowl length of 6 ft 8¾ in., height of blade and bowl is 32½ in. Cutting edge is reversible, with replaceable tips and can be raised 3 ft above ground. R. G. LeTourneau Inc., Peoria, Ill.

FORK TRUCKS. Capacities, 3000 and 4000 lb. For use in narrow aisles and congested areas. Outside turning radius, 73 in.; minimum intersecting aisles, 64 in.; right angle turn, 89½ in. plus length of load; single lift, 64 in.; telescoping lift, 126 in.; free lift, 63 in.; wheelbase, 43 in.; and weights, 6600 and 7500 lb with batteries. Baker Industrial Truck Div., The Baker-Raulang Co., Cleveland, O.

VIBRATING CONVEYOR. Motor-driven unit uses coil supporting springs. Handles materials to 100 fpm. Simple drive mechanism uses 3 bearings. Unit requires 14½-in. headroom from base to trough bottom. Conveying trough fabricated in wide variety of shapes, with screen, etc. Shephens-Adamson Mfg. Co., Aurora, Ill.

LIFT TRUCK. Revised model 20. Capacity, 2000 lb. Powered by air-cooled Wisconsin engine with new intake manifold, electric fuel pump and distributor. Features spark-arresting muffler, larger clutch, and uprights that tilt forward to lift front wheels clear for servicing. Tilt control of uprights accomplished through double-acting hydraulic cylinders. Hyster Co., Portland, Oreg.

Office Equipment

WATER COOLERS. Bottle and pressure-bubbler models have 3 temperature zones or compartments. Both coolers provide 50-degree drinking water

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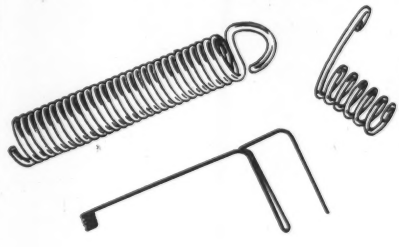

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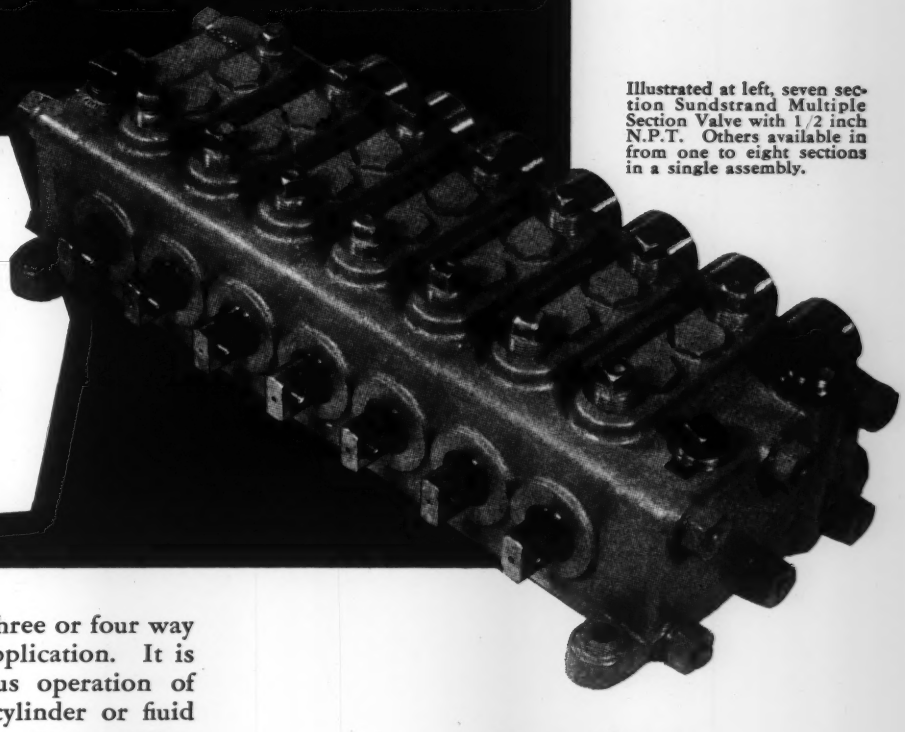

Illustrated at left, seven section Sundstrand Multiple Section Valve with 1/2 inch N.P.T. Others available in from one to eight sections in a single assembly.

Illustrated is a new Sundstrand three or four way Multiple Section Valve for series application. It is manually controlled for simultaneous operation of more than one actuated member (cylinder or fluid motor) from a single oil power source or pump, provided the total accumulated load on all actuated members does not exceed the relief valve setting.

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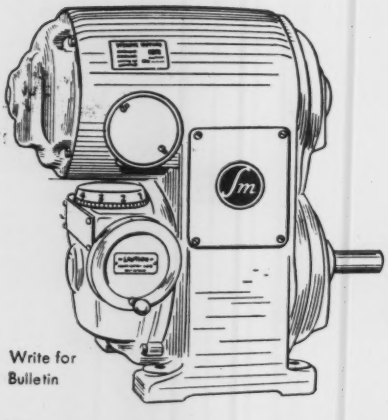

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Plant Equipment

STRAIGHT CENTRIFUGAL PUMPS. For use primarily on installations with flooded suctions. In close or long-coupled models. Capacities, 10 to 1000 gpm in 1 to 4-in. sizes. Consist of casing, impeller with shaft sleeve and ½ to 30-hp motor. Units can be installed in vertical or horizontal position. Marlow Pumps, Ridgewood, N. J.

AUTOMATIC CONTROLLERS. Consists of contact meter-relay with built-in micro-contacts and load relay rated at 15 amp, 115 volt, 7½ amp, 230-volt load. Indicating and controlling unit available in all ranges of voltage and current. Initial accuracy of calibration, 2 per cent. Repeatability of control point, 1 per cent. Differential between on and off, 1 per cent. Assembly Products Inc., Chagrin Falls, O.

DIAMOND WHEEL REFACER. For truing abrasive wheels from 1¾ to 2¼-in. diameter. Wheels clamped on mandrel driven by 115-volt, 50/60 cycle, totally-enclosed motor. Base equipped with suction unit to remove abrasive particles. Long pointed diamond in point of knurled headed screw adjustable in and out for varying wheel diameter. Tabor Instrument Corp., North Tonawanda, N. Y.

HEATING VACUUM PUMP. For buildings and plants having up to 25,000 EDR heating load. Combination condensate return and vacuum pump uses 1 centrifugal pump for both functions. Vacuum produced by water jet venturi system. Sealed against air leakage by mechanical seals. Available in single or duplex unit from 5000 to 25,000 EDR. American Hydrovac Inc., Brooklyn, N. Y.

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